POWER

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THE TIGHTWAD

By R. T. Strohm

EVERY time that the coal dealer renders his bills
You fly off the handle and rampantly rave,
While the fireman reddens from forehead to gills
At hearing you damn him for failing to save.
So you hector and threaten and bluster and shout,
You paw and you bellow, you bristle and yelp,
And you call him a blockhead, an ass, and a lout—
But say, Mr. Manager, how do you help?

HE may look like a dunce, but he happens to know
That heat by too heavy a draft may be drained;
Yet he hasn't a thing in the plant that will show
Just when the desirable point is attained.
You recall that he asked you to purchase a gage
To furnish a means of correcting the draft,
But instead of complying, you flew in a rage
And swore he was working a species of graft.

HE was doing his best with the things that he had,
But meeting with only imperfect success,
While efficiency varied from middling to bad,
Because it was governed completely by guess.
A thermometer's aid might have remedied that,
By showing the temperature of the feed,
Yet you jeered at his gall and you turned him down flat
The day he approached you to mention his need.

WHEN he asked for an Orsat, you snorted and glared
And fumed in the violent, bullying way
That you kept in reserve for the fellow who dared
To voice a request for an increase of pay.
Why, you blithering idiot, he could show gains
To merit your credit instead of your curse,
If you'd treat him as though he had something like brains,
And loosen the string that is strangling your purse.

Combination Electric Heating Plant, Laramie, Wyo.

By A. E. Anderson

SYNOPSIS—This power plant not only generates electrical energy, but the exhaust steam from the engines is used for district steam heating for about nine months of the year. Several home-made devices are described.

The electric plant at Laramie, Wyo., a city of about 9000 inhabitants, was one of the first in the West, having been installed in 1886. Originally it was a direct-current plant, but it soon proved inadequate and the change to alternating current was made in 1905.

The building, Fig. 1, is of brick with a wooden roof covered with patent roofing material. The engine room, 53x59 ft., is lighted by 100-watt Mazda lamps. Provisions for house lighting have been made by a supply line from either a transformer on a pole outside the plant, connected to the power line, or from the direct-current system.

When the present company took over this plant 2200-volt air-brake switches were in use and many primary

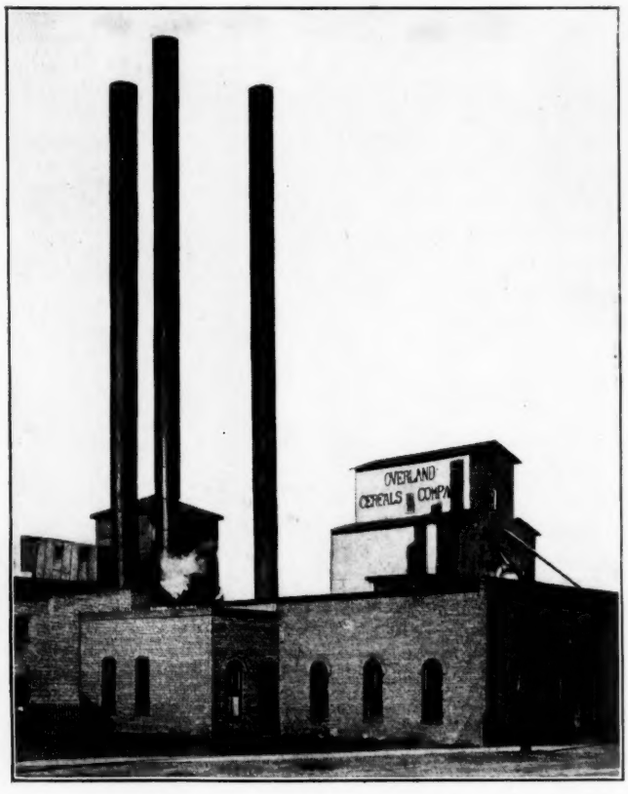


FIG. 1. THE POWER PLANT AT LARAMIE, WYO.

wires were supported on porcelain knobs on the ceiling and timbers of the tower, from which the leads went to the first pole. That no trouble ensued is probably due to the dry climate of this altitude (7132 ft.). Switching and wiring have been changed and not a wire is in sight in the engine room, conduit being used exclusively, even for the feeders, which run out to and up the pole, terminating in pot-heads.

Over one corner of the coal bin is a 14,000-gal. round, steel water tank for reserve purposes. The water level in the tank is 38 ft. above the floor of the engine room. The tank is supported by 12-in. I-beams which rest on opposite walls of the bin, reinforced by duplicate walls, tied together by 1½-in. bolts.

Coal and Coal Handling

The slack coal used is sub-bituminous, being a product halfway between lignite and bituminous. It comes from Larimer County, Colo., and the fracture shows a bright gloss. The flame is considerably longer than that from

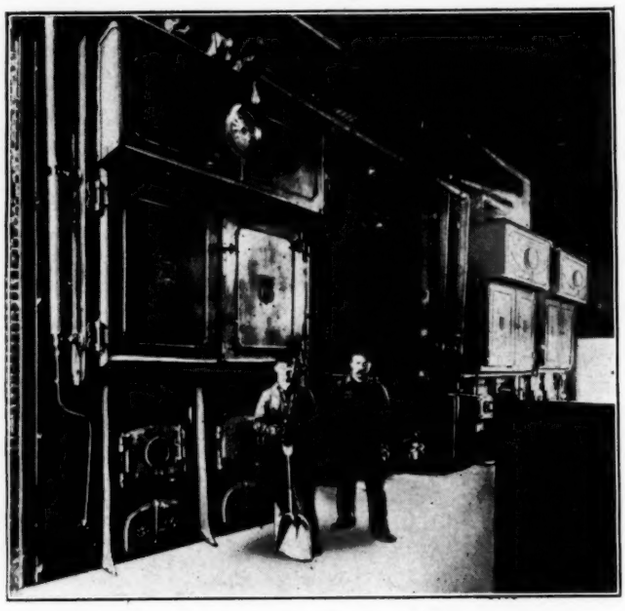


FIG. 2. BOILER ROOM WITH THREE BOILERS

lignite and, when burning rapidly and with a good draft, the flame is quite as long as that from bituminous coal.

Analysis of the coal gives the following: Moisture, 8.50 per cent.; volatile matter, 43.18; fixed carbon, 44.22; ash, 4.10; total, 100. Sulphur, 0.50 per cent.; British thermal units, 10,975. It has the objection common to coals of this character, of firing in the bin, but it can be used up as soon as heat is detected, a supply of coal being assured owing to the proximity of the mines.

A spur runs along the back of the plant, passing over a concrete pit with sloping bottom, into which the coal is dumped. At the plant side of this pit there is a hand-operated gate that regulates the amount of coal passing into the link-belt conveyor, which carries the coal over the wall of the plant, whence it is distributed by two chutes to either end of the coal bin. This conveyor is run by a 5-hp., 440-volt, three-phase motor and is inclosed from the weather. The motor is controlled by a switch, located in the wall of the coal bin close to the elevator. From 300 to 400 tons of coal can be stored in the bin—enough to last from three to four weeks during the winter season.

The steam-generating equipment consists of three water-tube boilers (Fig. 2), each with 2700 sq.ft. of

heating surface and 428 sq.ft. of grate surface. A pressure of 150 lb. is ordinarily carried, although this is dropped to 110 lb. during cold weather, when live steam is required to maintain the pressure in the district-heating system.

The boilers are hand-fired, the fronts being 12½ ft. from the openings in the coal-bin wall. Considerable attention is paid to the firing and the results obtained can be noted from the chart, Fig. 3, which was taken on Nov. 22 last, but one boiler being used during the 24 hr. Superheaters have not been considered, owing to the long heating season of from 8½ to 9 months.

Provision has been made for a fourth boiler as future conditions demand. Two of the boilers are placed wall to wall, an aisle being left between the second and third units.

The boilers are piped through 6-in. offsets to a 12-in. header. From the tee over the aisle another offset in the 12-in. pipe running to the engine room takes care of the expansion and contraction.

Two of the boilers have 90-ft. stacks, the third stack being but 80 ft. Naturally, the boiler the latter serves is unable to carry as heavy a load as the other two. Around each stack ample ventilated space is left at the roof, as a dry dusty condition of the coal oftentimes means a red-hot stack, especially with a heavily loaded boiler.

The blowoffs both from the steam drums and the back water legs are piped to a common blowoff header that discharges into a sump. This sump is watched to see that the blowoff valves are kept in a nonleaking condition.

One interesting point in connection with the boiler operation is that the safety valve, set for 155 lb., hardly ever opens, except when periodically tested. Besides the usual pressure gages, a recording gage is located where it can be watched by the firemen.

The feed-water heater is an old-style open, vertical type. As originally installed, before the steam-heating system was put in, exhaust steam escaped to the atmosphere through an 8-in. pipe attached to the top of this heater. Additional exhaust relief was found in an outlet through an old closed heater, which has since been removed. With this arrangement 170 deg. F. was the maximum temperature of the feed water. Heavy loads on the engines frequently had the effect of blowing water out of the heater and onto the roof.

On the installation of the heating system this was changed, the heater being raised to give a better gravity run of the hot water to the pumps, and the steam connection to the heater was placed on the end of the exhaust main with the atmospheric or back-pressure valve between the engines and the heater. In this way a sudden opening of the back-pressure valve has no effect on the heater, which takes steam as needed, an air valve being located on the top of the heater to prevent its filling with air. With 5-lb. back pressure in the exhaust line, temperatures of 214 deg. have been obtained, although, due to the altitude of 7132 ft., water boils at about 198 deg. While this water is very hot, no trouble has been experienced with the pumps, as their suction connections are close up to the heaters and are of proper size, with a minimum of fittings.

It has been found that weekly cleanings of the heater are necessary, and these have resulted in greatly eliminating scale troubles in the boilers. The feed water is obtained from the city mains and comes from a spring. The scale formation is hard, but is not fast forming, trimonthly cleaning of the boilers being sufficient to keep them in good condition.

An interesting kink in heater cleaning was noticed in this plant. When the trays are thoroughly cleaned, that is, with all scale removed and the metal of the trays showing bright and clean, they are worthless as scale retainers. When they are only partially cleaned and small patches of scale are left on, they serve their purpose admirably. The cleaning of the heater is considered an important item in the efficient operation of the plant.

Two duplex piston-pattern type pumps are provided for feeding boilers. One is a 6x4x6, the other 7½x5x6-in. They are placed with their water ends close to the heater. The discharge enters a common header, which passes over the boiler fronts and is branched to each boiler.

Before passing to the engine room, mention might be made of a device which tends toward efficiency of the combination plant. When a district steam-heating system is installed it takes some time before an appreciable load

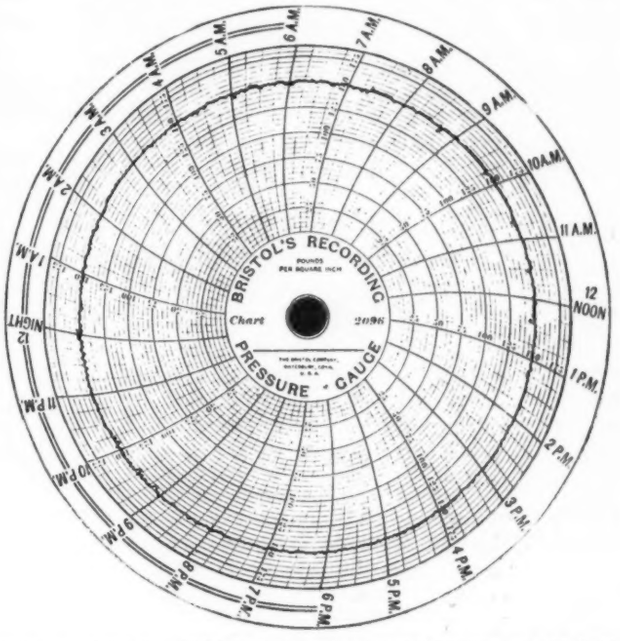


FIG. 3. CHART SHOWING STEAM PRESSURE CARRIED WITH HAND FIRING

is obtained. This was true of this plant. At peak electric-load periods it was noted that considerable steam passed through the back-pressure valve to the atmosphere and was wasted. It was also noted that the heat demand during the day far exceeded the exhaust supply. Here was an opportunity for increased economy. The first thought was to put one of the two old fire-tube boilers on end and pass steam through the tubes to heat the water inside, this water to be used during the day. However, this would have resulted in the necessity of putting in a pump to raise the water in this old boiler to the top of the heater.

It was finally decided to use the tank on the roof, and a tee was placed in the line just below the back-pressure valve. From the side opening of the tee a pipe was run to and into the tank, and a home-made heater was connected to the end of the pipe. The heater was made of a tee and two pieces of 3-in. pipe in which were drilled numerous small holes. The back-pressure valve is equipped with a bell alarm which notifies the attendant

that the electric load has so increased that the back-pressure valve is open, when the exhaust supply is greater than the demand for steam. A valve in the line to the home-made heater is then opened, and the surplus exhaust steam, filling this pipe and passing through the holes in the pipes, heats the water. This hot water is used during the day and is sent to the main heater for a second heating before going to the boilers. This device has worked out nicely and has resulted in increased economies. For months during the cold season, no steam issues through the atmospheric exhaust.

Engine Room

There are four prime movers in the plant, all but one being directly connected to their generators. Due to the electric-heating combination, they all run noncondensing. The largest unit is a cross-compound engine (Fig. 4), running at 225 r.p.m. It is equipped with a four-valve nonreleasing Corliss gear and is shaft governed. The cylinders are 14&22x17-in. The exciter is mounted on the main shaft between the generator and the low-pressure side. This engine drives a 185-kv.-a., 2300-volt, three-phase, 60-cycle alternator. It is the only three-phase unit in the plant, the other two alternating-current units being two-phase, the energy being converted to three-phase by means of compensators at the machines.

It was found that traces of oil were appearing in the heating system, so the automatic lubricator from the low-pressure cylinder of this engine was removed. Since then no further troubles from oil have been noticed.

Alongside the compound engine is installed a 14x36-in. simple Corliss engine. This is directly connected to a 150-kw., two-phase, 2300-volt generator running at 123 r.p.m. A home-made auxiliary governor consisting of an arm and weight was added to the governor of this engine for controlling the speed when synchronizing.

A third alternating-current set consists of a 14x14-in. twin slide-valve, high-speed engine, speed 200 r.p.m., belted to a 100-kw., 2200-volt, two-phase inductor-type alternator. This unit is maintained for emergency purposes only and is used but once in six months or so.

Any two of the three units will carry the heaviest peaks ever experienced in the plant.

The company maintains a portion of the old direct-current system, which includes some printing-machine motors, etc. This load is cared for ordinarily by a belted motor-generator set of 35-kw. capacity, 125 volts, actuated by any one of the prime movers.

This set runs with practically no attention or trouble. The synchronous motor has also been of use as a means of power-factor correction. There are weeks when the power factor never gets lower than 90 per cent., thus enabling practically the full capacity of the alternators to be utilized.

As an emergency apparatus for the direct-current system, a 13x12-in. high-speed engine operating at 280 r.p.m. is direct-connected to a 65-kw., 125-volt generator.

All engines, operating at 150-lb. pressure, are provided with steam separators and are connected to the steam main with long-radius bends. They exhaust into a common header, one end of which terminates in the boiler room, the other end in a heating pit.

The eight-panel alternating-current switchboard is of black slate and is modern in all respects. Three panels are for the exciter, three for the alternators, one feeder (light and power) and one synchronous motor-control panel. The feeder panel is equipped with two direct-current relays for operating the three-phase oil switches in time of short-circuit or overload. Close to the switchboard is the starting compensator for the synchronous motor. It is equipped with both no-voltage and overload relays.

The direct-current board is a relic of the old layout. One interesting feature of the system is that the voltage can be brought up from zero by the motor-generator set. The synchronous motor rotor is provided with short-circuited copper bars, so as to be self-starting, and the voltage on the direct-current generator can be brought up and the synchronous-motor field built up before the compensator is thrown to the running position.

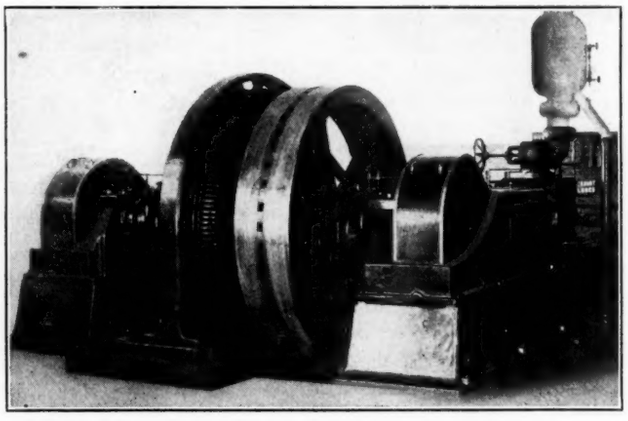


FIG. 4. CROSS-COMPOUND ENGINE AND GENERATOR

Heating Pit

As already mentioned, one end of the exhaust main runs to a heating pit. This is 5 ft. 1 in. by 9 ft. 10 in., and 12 ft. deep, and is located on the street side of the building. Just inside the pit is a 12-in. gate valve, for shutting off steam for repairs. Next is installed a "booster" fitting, a 45-deg. angle tee, with a 3-in. side opening to which is connected a 3-in. automatic reducing valve, the live steam being taken to the end of the 12-in. main in the engine room. Some little trouble was experienced with this valve for a while, the other valve opening and closing intermittently instead of throttling the steam. This was found to be caused by the fluctuations of the exhaust steam to the pilot valve and was obviated by partially obstructing the flow of steam in the pilot-valve line.

Next to the booster is a 12-in. separator for removing the grease and moisture from the exhaust steam. The grease and water are drained from the bottom of the separator to a steam trap, and then they go to a condensation meter that records all line losses to a point about half way on the heating main in the down-town district. From the meter the water drops into a 2x2x2-ft. subpit under the separator. The suction of a small deep-well pump dips into this subpit and as it fills the water is pumped to the sewer.

It is interesting to note at this point that the line losses decrease materially as live steam is put into the main, showing that the live steam evaporates the entrained moisture in the exhaust.

A recording thermometer on the switchboard is connected with the steam line by an armored copper tube,

terminating in a nozzle plug located at the wall of the pit, on the street side. This gives an excellent record of plant operating conditions affecting the heating system. A chart, Fig. 5, is shown herewith. The heating system has some 2,810,000 cu.ft. of space connected to its lines, this being about 74 per cent. of the present total building space available to the mains.

This plant has a good record in the way of noninterruption of service. In the three years since the heating plant was put in operation, there has not been a shutdown. The electric plant has a record of 18 months without an interruption during lighting hours, and a maximum nonavoidable interruption of 116 minutes in two years.

Strict attention is paid to economical operation. A number of tests have been run to determine which engine developed the greatest economy, under different conditions.

Engines and boilers are run at considerable overloads before additional units are cut in. When a machine is operating under a predetermined overload that it can safely carry, another machine is thrown in parallel. The boilers carry overloads as high as 70 per cent. for from one to two hours, with natural draft.

When the present owners took over the plant two boilers were used on the lighting peak. Last year two boilers were used for but three months out of the year. A tube failure is unknown in the plant. However, the service is hard on the furnace brickwork, and this is frequently renewed.

The oil consumption has been cut some 60 per cent. in the last two years. When the heating plant was first installed it was noticed that cylinder oil collected in the subpit. For a time this oil was skimmed off for use with the feed pumps. A study was made of conditions, however, and the conclusion arrived at was that too much oil was being used. Then the lubricator on the low-pressure side of the cross-compound engine was removed, a saving of cylinder oil was made, and the oil in the subpit was practically eliminated. The saving also included the nonuse of oil cups above the piston rods, which were declared unnecessary as the rod packing contained enough lubrication.

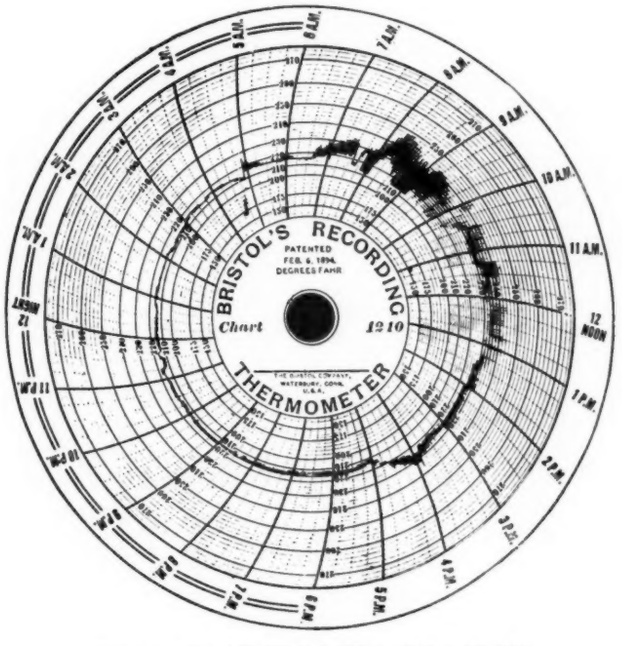


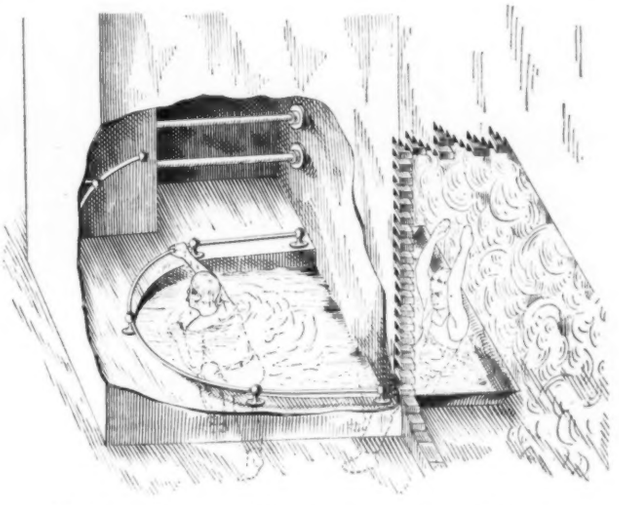
FIG. 5. CHART FROM HEATING SYSTEM

There are five operators in the plant. C. B. Arnold is chief engineer, and Charles Larson, night engineer.

In Case of Emergency

By Ernest H. Peabody

Considering the enormous use of power in modern times, accidents are rare—so rare, in fact, that small thought is given to the means of escape in time of danger. Were accidents to boilers, steam pipes, ammonia ice machines, gas tanks and the like as frequent occurrences as fires or the breaking loose of the elements, we would feel more keenly the necessity for providing emergency escapes from the confined compartments in which such machinery is frequently installed. The loss of a few lives at a time does not impress the general public as preventable and a thing that should be prevented at all costs, in so far as is possible.



WATER-SEALED EXIT, IN CASE OF ACCIDENT

The boiler and engine rooms of large office buildings are usually situated several stories below the street level, where the blowing out of a joint in a steam pipe or the rupture of a boiler tube fills the confined machinery spaces with suffocating vapor almost instantly. Safety for the men in these compartments lies in getting *out* and *up*, and yet the natural path of the cloud of hot gases is also *out* and *up*, the stairway or elevator shaft.

The machinery space of the modern steamship is even more contracted and congested, and with the firerooms closed and sealed air tight, when such a system of forced draft is used the chances for escape in time of emergency are small.

The requirements of a safe emergency exit from closed or partly closed compartments that may in case of accident become filled with steam or noxious gases are: Readiness for instant use at all times; elimination of all latches, doors or covers that take time to open; means for the free and uninterrupted passage of persons that may be in the compartment; arrangement and location which will render the use of the exit the instinctive impulse of those desiring to escape; most important of all—means for preventing the steam or gas from following through the exit.

The illustration shows an escape that has recently been devised and patented and which meets all of these requirements. In its simplest form it consists of a tank of water situated at the side wall of the compartment. This tank extends under and beyond the wall, on the other side of which is a passageway leading to safety. In other words, the wall divides the upper part of the tank into two parts, one of which is in communication with the dangerous compartment and the other in communication with a safe passage. The tank is deep enough to permit a person who jumps or falls into it to pass under the wall and emerge on the other side, and the wall or bulkhead projects sufficiently below the surface of the water to insure a perfect seal and to prevent the steam or gas from passing through to the exit. Handrails and steps or ladder rungs are provided to facilitate the escape of persons through the tank. Overflow and filling pipes insure the water being always maintained at the required level.

It would seem a very natural thing for a man, suddenly exposed to an outrush of steam or gas, to run and jump into an open tank of water, especially if he knew that it was a sure road to safety. An emergency exit of this kind is simple, inexpensive and sure in its results and it is the hope of the designers that it may be the means of saving many lives.

Notes on Overhauling the Refrigeration Plant--II

By F. E. Matthews

SYNOPSIS—Fully explains the bad effects of allowing scale and oil to accumulate on and in the condenser coils. Preventing "cold coils" in condenser operation. Attention to the jacket water, oil trap and ammonia pipe valves.

The efficiency of the condenser should be maintained as high as possible by keeping its surfaces free from deposit. The accumulation of scale, in retarding the heat exchange, increases the condensing pressure, requiring the expenditure of additional power to operate the compressor. If the heat-transmitting capacity of the condensing surface is allowed to become reduced 20 per cent., for example, because of the accumulation of scale, it indicates a degree of negligence equal to that which would permit 20 per cent. of the condenser coils to be inoperative. Because of the high temperatures encountered, the oil coating on the inside of the condenser is comparatively slight. But the hardness of the scale deposited by cooling water under high condenser temperatures more than offsets this advantage. Where the scale is soft and easily dislodged, no paint or other coating should be used on the condenser pipes, with the possible exception of the last few inches of the ends of the coils where, because of imperfect water distribution, the coils soon rust owing to being alternately wet and dry. Where the scale is hard the pipes may be coated with graphite and cylinder oil to prevent the scale from adhering closely. Few of the so-called paints will stick to condenser surfaces for any considerable time. All coatings, including paint, tend to decrease the efficiency of the heat-transmitting surfaces, and no substance should be employed that does not more than make up for its own insulating effect.

The double-pipe condenser does not have the advantage of the refrigerating effect due to evaporation of the cooling water in contact with the atmosphere, one of the principal assets of the atmospheric condenser. It does, however, possess the advantage of having all cooling surface constantly wet, while in the latter type slight variations in cooling-water pressure, slight obstructions in the supply gutters or lack of sufficient care in regulating the supply valves may cause part of the surface to be operating dry. The engineer should be unrelenting when it comes to insistence that all condenser surface, as well as all expansion coil surface, is working every minute the plant is in operation.

The advantage of more perfect water distribution in the double-pipe condenser is partly offset by the fact that the accumulation of foreign matter from the cooling water cannot be so easily detected as with the atmospheric condenser and cannot be so easily removed during operation. The presence of ammonia leaks is also more difficult to detect, though more easily permanently repaired. Leaks in condensers of the atmospheric type may often be located by the precipitation of impurities from the cooling water, thrown down by the ammonia. This is particularly true where salt water is used, as the ammonia has the choice of more different substances with which to react. Where the water is constantly running over the condenser, slight leaks may frequently escape detection. Occasion should be taken for carefully inspecting each coil whenever the water is shut off. In the case of double-pipe condensers, leaks can be detected by carefully examining the water which has stood in them for some time while the plant is not in operation. The effectiveness of this method, which should be employed whenever occasion permits, is somewhat influenced by the composition of the impurities in the water, as might be inferred from the statement that the precipitate formed by the ammonia and the various impurities contained in so-called salt water is more noticeable than with those of fresh water. If all the ammonia escaping into the cooling water finds sufficient matter with which it can react chemically the resulting substance will be without odor.

"Cold Coils" Cause Low Efficiency

"Cold coils" are another important cause of low condenser efficiency. Where a number of stands of condensers of the same design are set at the same level and connected in parallel to amply large headers, the pressure in all should be the same, and assuming that the cooling water is equally distributed, each should perform its proportionate amount of work. Since conditions are so nicely balanced, however, only slightly varied conditions suffice to disturb that balance to the extent of causing the

ammonia to pass into some coils to the exclusion of others. The disturbing element may be the accumulation of a slightly greater amount of permanent gases in the offending coil or it may be a slight obstruction in the pipe leading to the liquid header. The method usually employed to start the coil to operating is to shut off the water so that the coil may heat up. This is sometimes sufficiently effective. To disturb the new condition of balance would be more or less effective, but a more logical method (since it is impossible to produce any appreciable difference in gas pressure in a number of coils connected to a common header) would be to first purge the coil of any foreign gas and then turn on a large quantity of cooling water so that there will be additional inducement for the ammonia to enter the affected coil. The liquid valve may also be closed so that a considerable quantity of liquid may accumulate, thereby producing a slightly greater static head, which may be sufficient to start the coil to operating when the liquid is suddenly released by the opening of the liquid valve. If any particular coil gives nearly continuous trouble the liquid line and valve should be examined for possible obstruction.

In the early days of refrigeration little attention was paid to details of condenser design. The old submerged types have been superseded by the more efficient atmospheric types, to be sure, but in the last few years engineers have found that there can be great improvements made, even in the efficiency of condensers of the atmospheric type, by slightly changing the design and prescribing different methods of operation.

It is not the purpose of this article to treat of the comparative efficiency of different makes of condensers. Suffice it to say that it depends on velocities of the gas as well as on cooling surface and on the temperatures at which the liquefied ammonia can be conducted away from the condenser as well as on the velocity of the cooling water. In other words, not all atmospheric condensers having the same superficial surface will produce the same tonnage of work or deliver the liquid refrigerant to the receiver at equally low temperatures.

Attention Should Be Given Water Jacket

The temperature at which ammonia passes to the receiver is of importance, for before it can do useful work of refrigeration it must cool itself to the temperature of the refrigerator. If, as is too frequently the case, the receiver is located in a hot engine room and no precautions are taken to properly insulate it, together with the connecting pipes, there is little use of trying to get the last degree of cooling effect out of the condenser. The remedy is to remove the receiver and piping to a position at least as cold as the cooling water, or if this is impracticable thoroughly insulate the liquid line from the condenser-liquid header to the receiver, the receiver itself, and the liquid line from the receiver to the point where it enters the cold-storage rooms.

Two important parts of the system that seldom receive the attention they deserve are the compressor water jacket and the oil trap. The fact that the former does not get so full of mud that water will not circulate through it does not mean that it is doing its duty as a cooling device. The efficiency of the water jacket is low enough at best. The area of the heat-radiating surfaces is small, and the cylinder walls through which the heat must pass are thick. The total cooling effect produced by the water jacket under the conditions most advantageous to its operation can scarcely be expected to be more than in the same proportion to the total cooling effect as the area of the cylinder walls and head bears to the total condenser surface. In some designs the jacket is so placed that the cold areas of the compressor adjacent to the suction valves cool the water at one end of the jacket while it is being heated at the other. In fact, cases of negative efficiency are not uncommon in which the total effect is to cool rather than to heat the jacket water. The removal of the superheat in the ammonia at the end of compression and the mechanical advantages of having the discharge valves operate under as low a temperature as possible are of sufficient importance to warrant the care necessary to keeping the water jacket clean in all cases where operating temperatures are such as to render the jacket effective.

The fact that the oil separator is made to contain oil should not be taken as a reason for not cleaning it out thoroughly at least once a year. It may contain scale or other foreign matters that clog the blowoff valve and occasion a shutdown at some most unfortunate time.

Advantage should also be taken of the period of general overhauling to disconnect, clean and repair any expansion or stop valves that do not work properly. An expansion valve that fails to feed because of some slight obstruction, not only reduces the capacity of the plant in proportion to the expansion coil area made inoperative, but also lowers the efficiency of the plant because of inability to maintain the proper back pressure.

Taking Care of the Ammonia Valves

By simple manipulations which will suggest themselves to any operating engineer, the installation may be tested for leaky valves. The stuffing-boxes of all the valves should be examined and the packing loosened and treated with cylinder oil and graphite every few years, whether they appear to need it or not. The screwing down of a rusty valve gland under pressure is at best a hazardous undertaking.

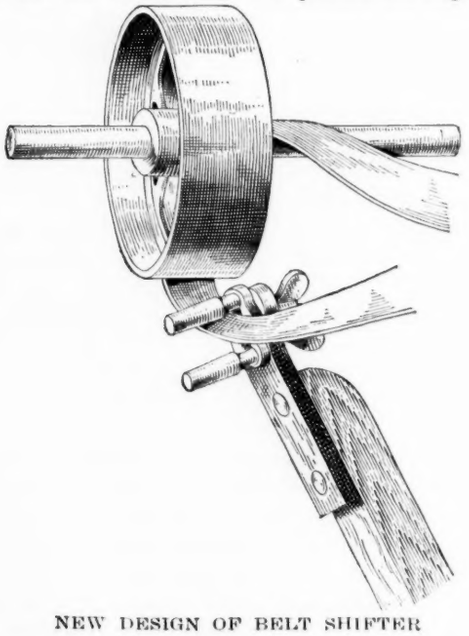
In most plants there are usually at least one or two ammonia leaks that have been allowed to go unrepaired until such time as the plant could be most conveniently shut down for general repairs. Steam leaks are expensive, but ammonia leaks are more so. The cost of generating the steam may be from twenty to twenty-five cents per thousand pounds. The cost of a pound of ammonia is as great. One leak is bad enough, but one of the worst results of letting an ammonia leak await a more convenient season for repairs is that its presence may mask one or more other leaks which might readily be stopped if their presence were known. Temporary repairs of ammonia leaks can be excused on the basis of the high cost of the escaping refrigerant provided they are permanently repaired at the earliest opportunity. A leak in the seam of an ammonia line may be stopped by the use of a hose clamp and a piece of packing, but this method is not to be recommended for a permanent job. Calking a fitting or a piece of pipe under pressure is never recommended, but is always done in case of emergency. It is always advisable to plan carefully just how one is going to get away and what he is going to do when he does get away, before starting in on an undertaking that may result in liberating a stream of anhydrous instead of stopping a

bubble of gas. Close-fitting automobile goggles are a good temporary protection to the eyes, often enabling a man to see to close a valve and get away in the length of time he can hold his breath under conditions that would make it impossible for him to return at all without a helmet and then only after a costly delay.

The escape of ammonia into the air can usually be detected by the smell, but since ammonia gas is lighter than air too great dependence should not be put on that means unless the air in contact with the highest pipes in the room is frequently explored by a sensitive nose. Even the compressor-rod stuffing-box leak of vertical machines may go undiscovered for a considerable time because of their position above a man's head when he is standing on the engine-room floor. When the air has become more or less charged with the gas, making it difficult to locate the leak by smell or by the use of sulphur sticks, the fumes of which turn white in the presence of ammonia, the joints suspected should be gone over carefully with soapsuds applied with a brush or oil applied either with a brush or a long-nosed oil can. A sore finger, one having an open wound, is by no means an unimportant accessory.

Safety-First Belt Shifter

A device to prevent accidents in shifting belts onto a pulley has been gotten out by the Ready Tool Co., Bridgeport, Conn. It consists of three rollers attached to an adjustable head frame. The two horizontal rollers are tapered and the vertical one is to protect the edge of the



NEW DESIGN OF BELT SHIFTER

belt. The whole is secured to a pole, as shown in the illustration.

The tapering of the two rollers tends to slide the belt onto the pulley and force the shifter away from it. The shifter is made in two sizes—one for belts from 1 to 4 in. in width; the other for those from 4 to 6 in.

A Flux for Brazing Cast Iron or steel parts consists of clean and finely powdered steel or iron, 60 parts; borax, 20 parts; petroleum or cocoanut oil, 10 parts; naphtha, 10 parts. These ingredients are mixed together to form a paste that should be applied to the surfaces to be brazed.—"Mechanical World."

The S. T. Uniflow Engine

The necessity for long cylinders and heavy pistons has prevented the consideration of the uniflow engine for locomotive service, although railroads are sadly in need of more efficient motive power. With the idea of producing an engine constructed on the uniflow principle that would be adaptable to locomotive service the accompanying design has been developed by Prof. H. A. Stringfellow, of the Mechanics Institute, Rochester,

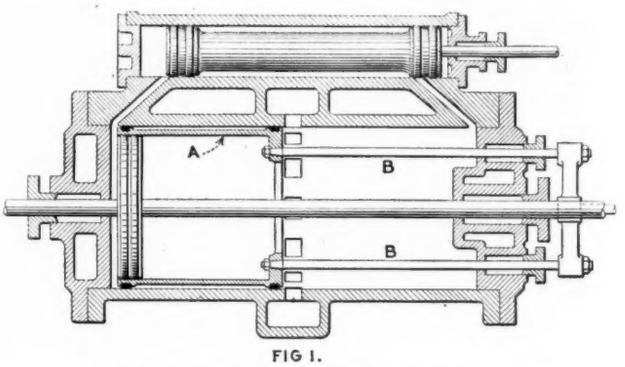


FIG 1.

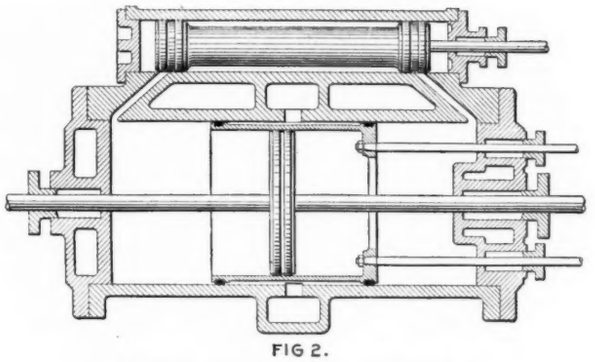


FIG 2.

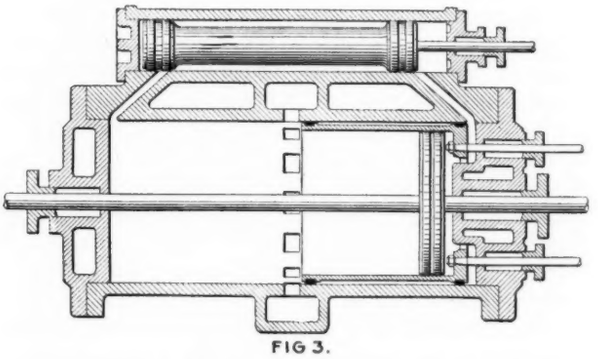


FIG 3.

STRINGFELLOW-TEMPLIN UNIFLOW ENGINE

N. Y., and E. W. Templin, assistant chief engineer of the Selden Motor Vehicle Co. Although primarily intended for locomotive service, this design can be used for stationary work and any type of admission valve substituted for the slide valve.

Fig. 1 shows a longitudinal section of the cylinder with the piston on the front center, Fig. 2 with the piston in the center of its stroke, and Fig. 3 with the piston on the back, or crank center. Instead of allowing the piston itself to open and close the exhaust ports, a sleeve A operated from the eccentric by the rod B is used, the length of which is equal to one-half the stroke less the width of the exhaust ports. This sleeve is provided with packing rings. The piston travels within the sleeve and

in the same direction as the latter, and as the speed of the sleeve is approximately one-half the speed of the piston, the latter never runs outside the sleeve. As the travel of both sleeve and piston is in the same direction, the steam pressure on what little end surface is exposed acts in the same direction as the motion and relieves the valve gear from a great proportion of the work of driving the sleeve.

The exhaust ports are placed at the middle of the stroke, instead of the end as in present engines of the uniflow type. Because of this location and the use of the sleeve, this engine will show a later point of release, as late a release as 92 per cent. of the stroke being easily attainable.

By setting the sleeve a slight distance behind the piston the latter can be made to reach the end of the stroke in advance of the sleeve with the result that release would be later in the stroke and the exhaust port would remain open for a longer interval while the piston was returning than it would if both the sleeve and the piston reached the end of the stroke at the same time. This gives more opportunity for the exhaust steam to leave the cylinder, and the movement of the piston aids in this exhaustion. If the width of the piston were made equal to twice the port opening, it would be theoretically possible to get 100 per cent. release, under which conditions the piston would travel a little over four times the port opening on the return while the port was opening and closing. The more complete the exhaustion the smaller may be the clearance, as the absolute pressure at the commencement of compression has a very material effect upon the pressure resulting from a given decrease of volume.

Limiting Factors in Forcing Boilers Above Rating

By Theodore Maynz*

SYNOPSIS—Discusses the conditions that limit the extent to which boilers may be forced and considers the alterations required in changing from low to high boiler ratings.

The tendency to force boilers at high overloads, continuously and during peaks, embraces several factors that must be carefully considered. These factors will vary if a plant is not designed for overloads.

The chief advantage of overloading boilers is the possible decrease in the investment cost, reducing the total power cost. This is not only due directly to less equipment but also to the need of less space and building requirements. The increased power obtained at high ratings is not necessarily accompanied by an increase in labor, but more often by a decrease, as a result of installing new equipment necessitated by overloading the boilers. The capacity of a plant may be trebled, or even quadrupled, without harming the equipment or subjecting the operators to danger or inconvenience. Keeping banked boilers to care for peak loads is unnecessary, resulting in a saving in fuel.

The disadvantages of high ratings when applied to new stations are not of such character that careful designing will not eliminate them; if not entirely, sufficiently for good operation. To get high ratings from old stations often necessitates so much reconstruction that the cost is prohibitive. Often the equipment as it stands will admit of moderately high ratings, such as 50 to 100 per cent. overload without any radical changes; but if higher outputs are desired, extensive alterations are required. Even with these alterations a compromise must often be made, and therefore the benefits of higher ratings are not completely realized.

The first essential feature for obtaining high outputs in stationary boilers is the adoption of stokers. These may be of the overfeed or underfeed type; but where the ratio of grate area to heating surface is limited the underfeed stoker has the advantage. Underfeed stokers of the dumping and self-cleaning types seem to be able to burn nearly any amount of coal desired, provided the stoker mechanism can shove it into the furnace fast enough and that there is sufficient air at a high enough pressure. Stokers of this type can easily consume 60, 70 and even 80 lb. of coal per sq.ft. of grate area. With high air pressures—that is, 7 and 8 in. static—there should be no difficulty in burning upward of 100 lb. per sq.ft. per hr. Even at these high ratings the furnace efficiency is high, 13 to 15 per cent. CO_2 being continuously obtained, while the combustible in the ash is low.

Using chain-grate stokers, the coal burned per square foot of grate is lower and as these stokers are generally used with natural draft, high ratings are not usually desired. However, due to the extension furnace settings used with these stokers, a larger machine is usually installed, and as these stokers are adaptable to forced drafts of ¼ to 2½ in. of water, high ratings can be obtained. In one power station similar results were obtained in boiler capacity with chain grates of 130 sq.ft. area and a total draft head (furnace draft and blast pressure) of 0.7 in., and with underfeed stokers of 92-sq.ft. area and operating with approximately 5-in. draft.

Even when burning small anthracite coals, No. 3 buckwheat and smaller, on traveling grate stokers of special design capacities of upward of 260 per cent. rating have been obtained, 50 lb. of coal per sq.ft. grate area being burned with about 2-in. blast pressure.

With overfeed stokers as much as 35 and 40 lb. of coal per sq.ft. of projected grate area have been burned, while the steel angle of these stokers and their extension settings allow a comparatively large area of stoker for a given furnace. These stokers have been successfully used with forced draft, and 300 per cent. boiler rating has been obtained for short periods.

We can easily see that by choosing a sufficiently large stoker, preferably of the forced-draft, underfeed self-cleaning type, either hand or mechanically dumped, the quantity of coal burned need only be limited by the wishes of the operator. The curve, Fig. 1, shows the draft re-

*Engineer, Combustion Engineering Corporation, New York city.

quired to burn both high and low volatile bituminous coals on various types of stokers.

The next factor to consider is the boiler itself. The rating of practically all modern boilers is based on 10 sq.ft. of heating surface in contact with hot gases, and at 34½ lb. evaporation from and at 212 deg. F. we have 3.45 lb. of evaporation per square foot of heating surface. At 300 per cent. of rating this is increased to 10.35 lb. In

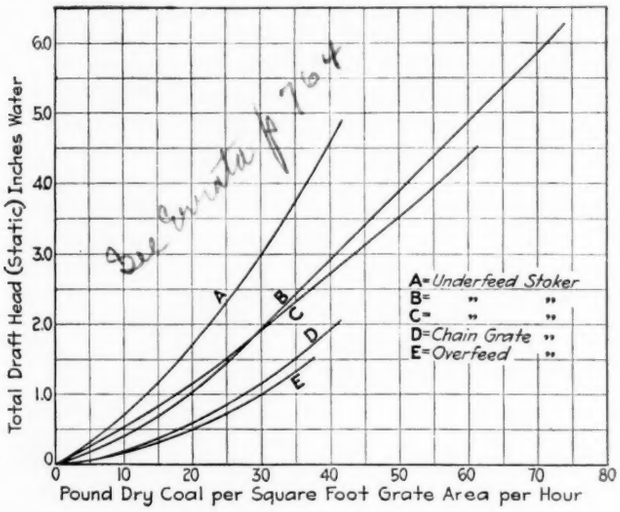

Total Draft Head (Static) Inches Water
Pound Dry Coal per Square Foot Grate Area per Hour
A=Underfeed Stoker
B= " "
C= " "
D=Chain Grate "
E=Overfeed "

FIG. 1. COMBUSTION RATES WITH VARIOUS DRAFT PRESSURES IN DIFFERENT STOKERS

both marine and locomotive boilers 10 lb. of evaporation per square foot of heating surface is common practice, 15 lb. and greater being often obtained. There is therefore no real reason why stationary boilers may not be driven at these ratings. The requirements are scrupulously clean tubes, inside and outside, the former in some cases requiring a separate water-treating installation, the latter requiring automatic soot blowers, and sometimes even soot brushing or scraping devices. This is not only necessary for obtaining high outputs and efficiencies, but also for the safety of the operators because of the chances of tube failure. At this point it may be well to mention that at high ratings, especially with underfeed stokers, the cinder problem becomes of large importance, not only in respect to city ordinances but also in regards to the coating of boiler tubes with stalactites and heavy soot deposits back of the bridge wall.

With proper furnace design all dense smoke can be eliminated. Even when burning as high as 60 lb. of coal per square foot of grate area no smoke need be visible. Smoke has been eliminated in conjunction with standard Class A Stirling boilers, equipped with underfeed stokers set directly beneath the tubes without any arches or Dutch ovens, forced as high as 250 per cent. rating while burning high volatile slack coal at 55 lb. per sq.ft. of grate area.

The rise in flue or uptake temperatures when driving boilers can be regulated by both the furnace and the boiler design. Large combustion chambers are necessary, so that complete combustion may occur before the gases are chilled by their contact with the tubes, allowing secondary combustion in the rear passes of the boiler. The design of ignition arches for overfeed stokers, both spring and flat, must be carefully considered, so that their upkeep is low and so that there may be sufficient furnace area for combustion. The benefit to be derived by using the direct radiation of the incandescent fuel in reducing the furnace temperature, and thus the temperature of the escaping gases, should be taken advantage of. This is especially true of horizontally baffled boilers, where tile should be used, preferably between the second and the third row of tubes, rather than C or box tile. The advantages of the three-pass boiler over the two-pass, and, similarly, the four-pass over the three should be considered. With vertically baffled boilers a high, narrow boiler is preferable to a low wide one. Thus, for high ratings a horizontal boiler, vertically baffled, 18 tubes wide by 14 tubes high, is preferable to the same horsepower boiler 21 tubes wide and 12 tubes high. The result of this change is practically equivalent to adding six extra rows of tubes in the gas passage, or using a 3½-pass boiler. The stratification of gases by the use of smaller and more tubes will also lower the flue temperatures. This is shown in Fig. 2 for two similar Babcock & Wilcox boilers, one with standard 4-in. tubes, 12 high and 21 wide, the other with the upper bank of tubes replaced by 2-in. tubes—that is, four 2-in. tubes replacing one 4-in. tube, the lower deck of 6 by 21, 4-in. tubes remaining in place. This latter boiler was built and tested under the direction of H. G. Stott, of the Interborough Rapid Transit Co., at its 74th St. station. This increased the ratio of heating surface to grate area from 56:1 to 81:1. The resulting flue temperatures, based on per cent. of boiler rating—520 hp. for one and 750 hp. for the other—show some interesting results. There is another factor that might account for the difference in temperatures; that is, the restricted circulation in the upper tubes probably increased the circulation in the lower ones, where the greatest effect is obtained, reducing the furnace temperature by increasing heat absorption and producing lower flue-gas temperatures.

If it is impracticable sufficiently to reduce the flue gases by the use of a four-pass, high-and-narrow, or small-tube boiler, the use of an economizer might be advantageous. This feature requires special consideration in respect to its adoption and design. Each boiler plant must be separate-

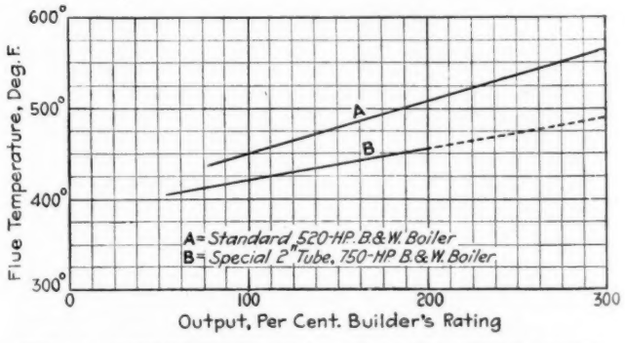


FIG. 2. INCREASE OF FLUE TEMPERATURE WITH INCREASE IN RATING

ly analyzed, as the advantageous use of an economizer depends primarily on the load curve and the cost of coal. The reduction in flue temperatures and the consequent loss in available draft need not be considered, as the use of an economizer in conjunction with high-rating boilers requires an induced-draft installation. This form of draft is usually needed when cinder catchers or washers are used, as these fixtures cause an appreciable draft loss. Therefore the maximum reduction in flue temperatures is desirable when economizers are utilized. Space is not available here for the discussion of economizers, but it might be well to bear in mind that an economizer not only entails

maintenance and operation charges, but that an appreciable amount of power is required to operate it. Also an economizer installation should be charged with the extra floor space required. At the same time the much greater efficiency of economizer surface compared to boiler heating surface and the possibility of designing a boiler plant with an overall efficiency of from 85 to 90 per cent.

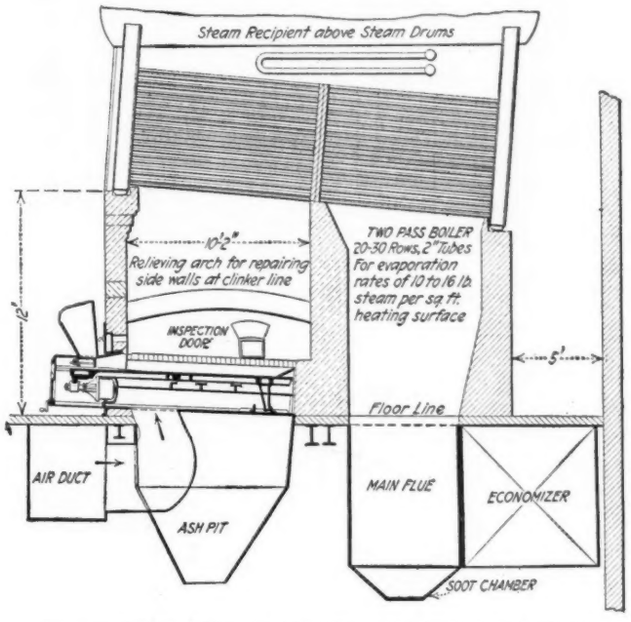


FIG. 3. SECTION OF BOILER FOR HIGH RATINGS

are inducements. A suggested scheme for utilizing waste space for the installation of an economizer and taking advantage of the high efficiency of economizer surface would be the use of a two-pass vertically baffled boiler, built high and narrow, with standard-length 2-in. tubes. The arrangement is shown in Fig. 3 and needs no explanation, except that the extra furnace length would be of decided advantage for the installation of most stokers, as in this type the ratio of grate area to heating surface should be no less than 1 : 50, and preferably 1 : 40.

The next consideration is the draft requirements for high ratings. By the use of underfeed stokers forced draft takes care of the loss through the grate and fuel bed. This allows of a furnace-draft requirement of not more than 0.05 in. of water, while in case of necessity the boilers may be run for short periods with a slight pressure in the firebox. Compare this to natural-draft stokers, where a draft drop of 0.3 or 0.4 in. is required through the fuel bed. The greatest loss is through the boiler itself. Fig. 4 shows the large increase in draft loss in the boiler, between the furnace and the uptake. The curves were drawn from observed results obtained in various tests and are self-explanatory. They also show the increased draft losses when a high narrow boiler is used instead of a low wide one. Though the writer at present has no data available for horizontally baffled vertical and inclined tube boilers, there is no doubt that from the observations that have been made they have similar characteristics in this respect.

A place where the draft loss is considerable, but often overlooked, is at the breeching. Draft losses as high as 0.5 in. have been observed under high ratings. The flue area should be large, and with a minimum number of turns. This is almost as necessary with induced draft as with natural, as the power required for operating draft fans will be reduced. Incidentally, where peak loads are of short duration it is often possible, with well-designed flues, to shut down the induced-draft fans for the periods between peaks, provided a high chimney is used. With newly designed plants having induced-draft fans for peak loads it would be obviously uneconomical to install a sufficiently high stack for this purpose, as the investment charges on the equipment must be paid whether in operation or idle, and a substantial sum may be saved in the first cost of the chimney. In old plants with high chimneys where it has been found necessary to add induced draft to operate the boilers at overloads during peaks a saving can be made by using natural draft during off-peak periods. Under these circumstances of frequent starting and stopping motor-operated fans would probably be economical.

The last factor to consider is maintenance, both on the boilers themselves and on the setting. There is no question but what boilers must be cleaned more frequently when forced than when operated at rating. This would seem to militate against the use of high ratings, but it is not as serious as it seems. The necessity of boiler repairs and tube replacements under forcing conditions is no more than at lower ratings, provided the boilers are kept clean. All boilers, no matter how lightly loaded, should be turbined once a year, preferably every six months. When forcing boilers cleaning should be frequent; but one must remember that there are fewer boilers in the plant to be cleaned, which nearly balances the cost of more frequent cleaning.

That the brickwork maintenance increases with the rating is obvious; but how much, depends on the quality of the brick, the characteristics of the coal and the work-

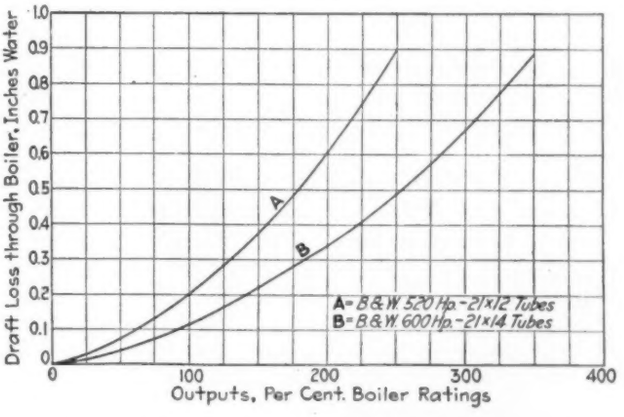


FIG. 4. DRAFT LOSSES THROUGH BOILER AT VARIOUS RATINGS

manship of the masonry. None but the highest grades of firebrick should be used, and it might pay to line the furnace with bauxite or silica brick at the clinker line.

When the physical properties of the coal are such that clinker trouble and brick erosion are extreme, steam jets in the side and bridge walls often help, while sometimes water backs will overcome the difficulties. The question of brickwork requires separate investigation in nearly every plant, but should present no unsolvable problems.

There are a few minor points yet to be considered, such as the capacity of the steam pipes and the moisture in the steam. A few years ago 6000 ft. per min. was considered the maximum steam velocity allowable in mains,

but now velocities of from 12,000 to 15,000 ft. per min. are not uncommon, so that often no changes need be made in the steam pipes when changing from low to high boiler rating. Safety-valve capacities should be increased sufficiently to meet the new capacity of the boiler.

Moisture in the steam will increase rapidly at an evaporation rate of 10 lb. per hr. per sq.ft. of heating surface, so that it may be advisable to install a separator or steam recipient[1] between the boiler steam connection and the stop valve, as even a superheater will allow slugs of water to pass through into the mains. If this is inconvenient, large receivers between the boiler-room mains and the engine mains can be used. These need have no baffles, but should be kept drained.

There are really no disadvantages to forcing boilers that cannot be readily overcome. To prove this, there are many plants in successful operation today that are using their boilers at from 200 to 250 per cent. of rating continuously and from 300 to 400 per cent. during peak loads. In new plants the degree to which boilers may be forced is merely a simple problem in accounting, balancing the decrease in labor and investment charges on the boilers against the increased fuel used and the extra equipment required, such as draft fans, economizer, purifiers, etc. In old plants there is the same problem, only slightly altered, with the additional questions of the costs of scrapping serviceable but unsuitable equipment. The final question relative to changes needed for higher ratings is, What will they cost per 1000 lb. of steam, and will they pay?

The Republic Flow Meter

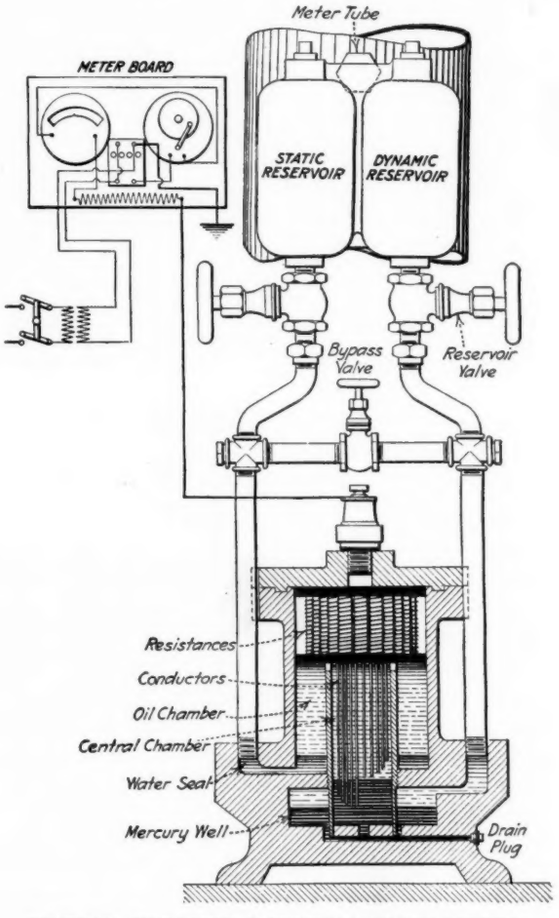
The Republic flow meter has been developed recently to such an extent that in measuring steam, water, air or gas, it compares in accuracy and convenience with the standard wattmeter or ammeter. This apparatus was described in the Nov. 24, 1914, issue of *Power,* and by comparison of cuts shown at that time with the accompanying illustration, the development can be observed. The principle remains the same, which is that of a U-tube containing mercury.

Contact wires of graded lengths are suspended over the mercury in the central chamber, each wire being connected to a resistance immediately above. A circuit is formed of the resistances, contact wires, mercury and ground, a current of given voltage, usually 38 volts, being applied. All the resistances are in series with one another, and as the mercury rises as a result of the application of pressure on the surface of the mercury in the large chamber, a number of resistances are short-circuited. A definite quantity of current now flows through the circuit, actuating the indicating, recording or integrating instruments.

The resistances are of such magnitude that the quantity of current flowing at any time is a direct function of the velocity of the fluid flowing in the pipe, and therefore also of the quantity of fluid. The pointer of the indicating instrument moves equal distances for equal increments of velocity of flow.

The form of pitot tube used is a departure. It consists of two tubes extending completely across the pipe, impact holes being provided in one tube at the proper intervals. Each hole is located in the center of an annular ring, the cross-section of the pipe being divided into half as many equal-area annular rings as there are holes. The other tube is the aspiration tube and is identical with the impact tube. These tubes are placed back to back and are inserted in the pipe so that the impact holes will point upstream, and the aspiration holes downstream. It has been found by actual experiment that this arrangement of impact holes results in the true mean of the velocities existing in the pipe.

The upstream side of the pitot tube is connected to the dynamic side of the mercury well, and the aspiration tube is connected to the other side of the mercury well. This results in the mercury being elevated in the central chamber to a height proportional to the square of the velocity of fluid in the pipe. The illustration shows that water



SECTION THROUGH REPUBLIC FLOW METER

is not permitted to touch the resistances or the contact wires, because of the oil seal.

A new feature is the micrometer adjustment for raising or lowering the resistance spool from the outside. In establishing the zero point the bypass valve is opened and the height of the contact wires is adjusted until the reading instruments show that no current is flowing.

Any combination of indicating, recording or integrating instruments may be connected to this meter. For example, an indicating meter may be mounted on the boiler front and the recording instrument in the engineer's office. Besides, the instruments may be duplicated, as any number may be connected to the same flow meter. The Republic Flow Meters Co., of Chicago, is the maker.

[1] An individual header for each boiler.

To Drill Tempered Steel or other hard material (even glass) use a drill tempered as hard as possible and camphor and turpentine equal parts in place of oil on the drill.

Draining High-Pressure Steam Piping

By Charles L. Hubbard

SYNOPSIS—Explains and illustrates the various requirements of drainage systems for high-pressure steam pipes. Different arrangements of drip pipes and separators are shown and the Holly system of handling drips is considered.

The drips from high-pressure piping are usually classified as high-pressure and low-pressure, the former including the drainage of all headers and piping under boiler pressure, also the cylinder jackets of engines, reheating coils of receivers, and separators. Condensation from these sources, being free from oil, is usually returned to the boilers. Water in the high-pressure piping is dangerous. If carried into the engine cylinders in considerable quantity it is liable to wreck the engine or at least rupture the cylinder heads; and condensation in the mains is likely to produce water-hammer, which in turn causes vibrations tending to loosen the joints.

Water in sufficient quantities to produce slugs the full size of the pipe is capable of serious damage when steam is first turned on or sudden changes in pressure occur in the system. The presence of moisture also reduces the efficiency of the engine to some extent, as it increases the conductivity so that more heat is absorbed from the cylinder walls and carried off with the exhaust.

Water finds its way into the piping in the form of moisture carried over in the steam from the boiler, and is also produced by condensation due to radiation. The amount carried over depends much upon the construction of the boiler, and commonly runs from 0.5 to 5 per cent., which may be increased before the steam reaches the engines by condensation in the piping. If the boilers are poorly proportioned or forced greatly beyond their rating, the percentage of moisture will be increased considerably above the figures given.

Removal of the Moisture

It is evident that in the design of a new plant the matter of drainage should start with the prevention of moisture being carried out of the boiler with the steam. This forms a part of the boiler design and may be reduced by providing ample surface for the separation of the steam from the water, plenty of steam space, a sufficient superheating surface, and may be further reduced by the use of internal dry pipes. Water carried over in the steam and that produced by condensation in the piping must be removed by drips and separators.

While there are certain general rules to be followed in designing and installing drainage systems, it is sometimes difficult to tell what changes are going to take place inside the piping. Unbalanced pressures within the returns of either a drainage or heating system often give the engineer much annoyance before they are located and overcome. One point to be borne in mind is that maximum conditions must be always provided for. A drainage system may have ample capacity for normal conditions, but prove inadequate when steam is first turned into the cold piping, when water is carried over from a foaming boiler, or when an additional unit is cut in too rapidly. Conditions at such times are especially trying for the drainage system, not only because of the increased amount of water to be cared for, but on account of the unbalanced pressure produced, which tends to drive slugs of water through the piping with tremendous force.

Separators are relied upon chiefly to prevent water from reaching the engine cylinders, although they should be supplemented by a sufficient number of drips to remove the condensation from all unavoidable pockets or low points in the piping between the boilers and engines.

The essential features of a good steam separator are its efficiency as an eliminator of water, sufficient storage capacity in case of a sudden rush of water from any cause, simplicity of construction and ample port opening in order to reduce the resistance to the flow of steam to a minimum.

The Efficiency of Separators

The efficiency of a separator depends largely upon the velocity of flow. In all instances the size for a given place should be fixed by the volume of steam passing through it rather than by the size of pipe with which it connects. The proper velocity of flow for the highest efficiency will depend upon the design and construction of the separator, and should be determined by the makers. A series of tests reported in *Power,* May 11, 1909, showed that at a velocity of 500 ft. per minute all of the different makes tested were equally efficient. When the velocity was increased to 5000 ft. there was a considerable variation, some having but little effect upon the removal of moisture under these conditions.

A separator of good design, properly proportioned for its work, should remove nearly all of the moisture when there is less than 10 per cent. There are so many designs upon the market that no attempt will be made to describe them. They may be classified, however, as centrifugal, reverse-current, baffle-plate and mesh, according to the principle upon which they operate.

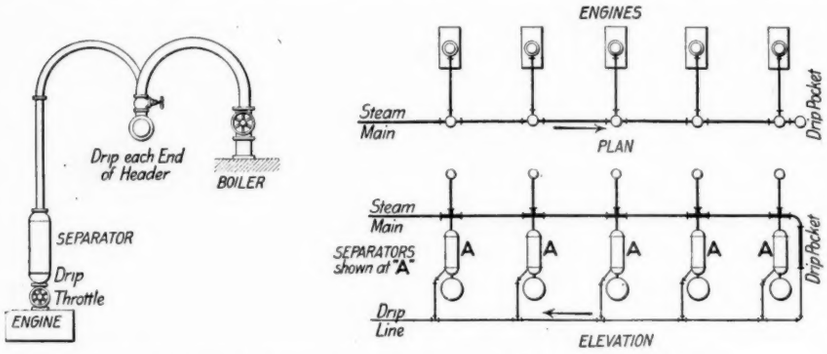
In general, the separator should be located as near the cylinder as possible, and the current practice of placing one of the vertical type just above the throttle valve is to be commended. When this is not convenient on account of insufficient space, the separator may be placed in a horizontal portion of the steam pipe, but should be as near the engine as possible.

Receiver separators having a volume three or four times that of the high-pressure cylinder are especially desirable where the load is likely to fluctuate suddenly. This arrangement acts as a cushion and also furnishes a large supply of steam at boiler pressure near the cylinder. The steam pipe in this case may be made one or two sizes smaller than called for by the engine connection, although the separator and throttle should be of full size.

As already stated, drips of suitable size should connect with all low points in the system, which, of course, includes the separators—and the throttle also, unless a

vertical separator is used above it. A typical arrangement of piping between boilers and engines is shown in Fig. 1. In cases of this kind a drip should be provided at each end of the main header and at each separator.

Sometimes a single main is carried to the engine room, as shown in Fig. 2, and leads taken off for the different



FIGS. 1 AND 2. DRIP ARRANGEMENT FOR ENGINE PIPING

units, as indicated. Here the flow of steam is in one direction and drainage may be through a single drip at the end of the line. Under these conditions the main should be kept the full size for its whole length and a reservoir formed at the end by means of an elbow and vertical section of pipe, with the drip connection as shown. Sometimes the ends of a main header, shown in Fig. 1, are turned down in a similar manner to form drainage pockets. Another method is shown in Fig. 3, where tees are used at the ends. The purpose of pockets or reservoirs of this kind is to catch any sudden rush of water. To be of maximum advantage the vertical drop should be equal to about four times the diameter of the pipe.

A typical arrangement of throttle and cylinder drips, where the separator is at some distance from the engine, is shown in Fig. 4. Although the drainage from the

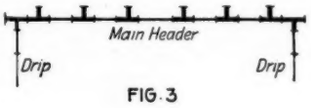


FIG. 3

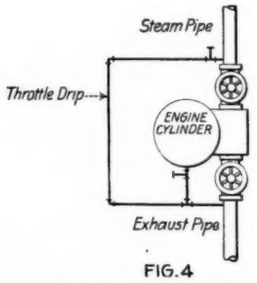


FIG. 4

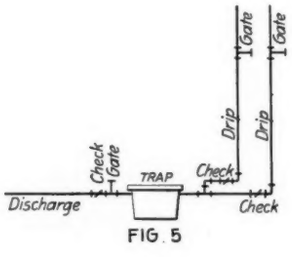


FIG. 5

FIGS. 3 TO 5. DRAIN PIPING FOR MAIN HEADER, ENGINE AND FOR TRAP IN DRAIN MAIN

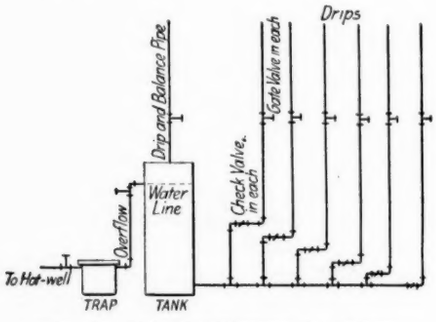


FIG. 6. ARRANGEMENT OF DRIP RECEIVER AND ITS PIPING

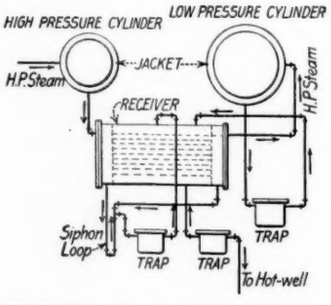


FIG. 7. DRAIN FOR CYLINDER AND RECEIVER, COMPOUND ENGINE

throttle is free from oil, the quantity is small and not usually worth saving.

The size of drip pipes is usually fixed by the outlets left by the makers in the case of separators, while ¾- to 1-in. pipes are used for main headers, depending upon their size. Throttle and cylinder drips are commonly given a uniform diameter of ½ in. The drip pipe is not expected to care for any sudden rush of water, reservoirs or pockets being provided for this purpose; hence, there is no advantage in making them of large size.

The condensation from high-pressure drips is commonly trapped to a receiving tank or dry well, from which it is pumped back to the boilers.

Where the drips are widely separated, individual traps should be provided, as there is likely to be difference enough in pressure to cause a backing of water from one pipe into another. When two or more drip pipes are taken from points near together, and where the pressure difference is likely to be slight, they may be connected with the same trap, it usually being best to seal them by means of a check which carries a slight water column above it, as shown in Fig. 5.

When drips coming from different sections of piping which are likely to be shut off are connected with the same trap, both check and gate valves should be placed in the connections. If the main valves in the steam piping are so located that there is danger of overlooking the drip pipe valve, it is much better to provide a separate trap, although the check would probably prevent serious damage even if the gates in the drip pipe were not closed.

A method of grouping the drips so as to employ a single trap is shown in Fig. 6, and is applicable to cases where the piping arrangement is fairly compact.

Here the drips, with the exception of one, are brought into a receiving tank below the water line, each being provided with a gate and check valve. The nearer drip, and one which is likely to be in use at all times as from the main header, is connected above the water line to serve as a balance or equalizing pipe. When the water in the tank rises to a certain point it overflows into the trap and is discharged into the pump receiver or hotwell.

Drainage from Jackets and Receivers

A typical method for draining the jacket and receiver of a compound engine is shown in Fig. 7. Steam at boiler pressure is admitted to the jacket of the high-pressure cylinder; from here it passes with the condensation which has formed into the coil of the receiver, and from there goes to the jacket of the low-pressure cylinder. The condensate is trapped into the shell of the receiver;

also that from the heating coil. The receiver itself is drained through a trap to the hotwell.

This system returns the condensate from the various high-pressure drips back into the boiler without the use of traps or pumps.

The principle is illustrated diagrammatically in Fig. 8. The various drips are brought separately into a receiver located below the lowest point to be drained. From here the condensate overflows into a riser through a series of

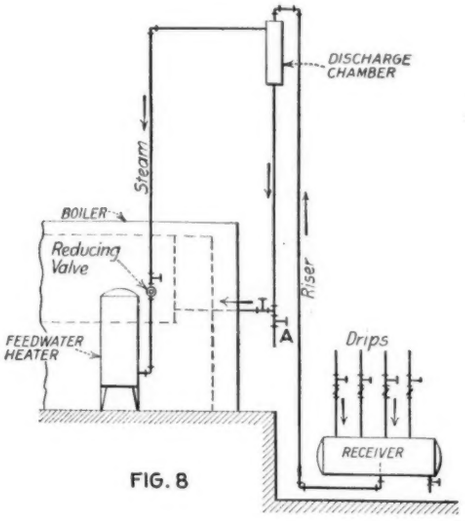


FIG. 8

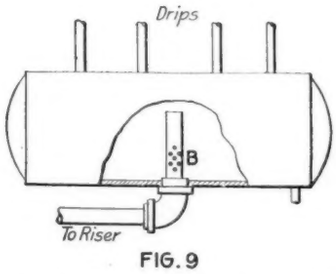


FIG. 9

FIGS. 8 AND 9. DIAGRAM OF HOLLY SYSTEM

small holes (see *B*, Fig. 9), the riser extending to a standpipe or discharge chamber placed at a considerable height above the boiler. A pipe leads from the top of this chamber, through a pressure-reducing valve, to the feed-water heater, while another leads from the bottom of the chamber to the boiler below the water line. In operation, a sufficient quantity of steam is allowed to pass from the top of the discharge chamber through the reducing valve to produce a slight upward flow through the riser, thus carrying water from the receiver in the form of a fine spray. As the pressure in the discharge chamber is nearly the same as that in the boiler, the water flows back by gravity because of its greater elevation. The system is started by opening the overflow valve *A* until steam appears, after which it is closed and the circulation, once established, continues until the plant is shut down.

Force is that which tends to produce motion. (Capital in the bank.)

Work is the product of force through space. (A certain amount of capital spent.)

Power is the product of force through space in a given time, or the rate at which force is doing work. (The amount of capital spent in a given time.)

The "Simplate" Valve

To insure higher mechanical and volumetric efficiency and to simplify air-compressor cylinder design, the Chicago Pneumatic Tool Co., 1080 Fisher Building, Chicago, Ill., has recently placed on the market the "Simplate" valve, which is of the flat-plate design. The valve has several distinctive features and the chief advantages claimed for it are that it is simple; that its plates are independent in action, one of another; that each plate has its individual springs; that the tensions of the springs on the inlet and discharge valves differ according to the

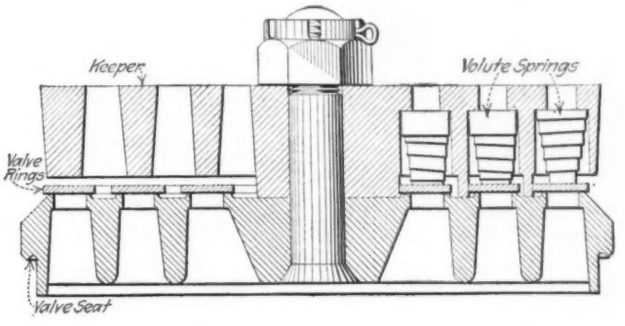


FIG. 1. "SIMPLATE" DISCHARGE VALVE

density of the air handled; and finally, that it is applicable to all positions and conditions.

Fig. 1 shows a section through a discharge valve. The seat is cast from a special alloy steel, heat-treated, oil-tempered and ground true on one side. As shown in the illustration, the seat has circular ports and it is machined so that the raised portion, or the point on which the plates rest forming the joints, is narrow, thus reducing the unbalanced area of the valve. The keeper is of the same material. It is provided with suitable ports for the free passage of the air through it and also furnishes guides for the valve plates and pockets for the valve springs. The latter are of the volute type and are made of high-grade crucible steel. The valves are simple concentric steel plates of uniform section, with a separate and independent plate over each port. Each plate is independently governed by its own spring, hence the action or opening of each valve is entirely independent of the other.

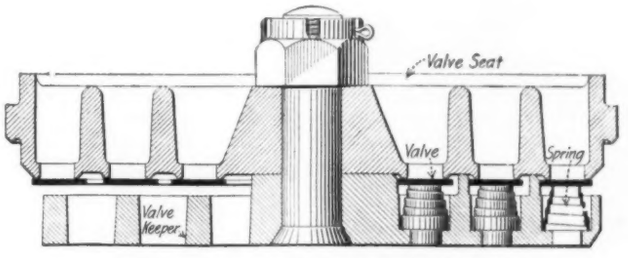


FIG. 2. "SIMPLATE" INLET VALVE

Should one of the plates open, the next one to it does not need to move unless the speed conditions should demand it. Ordinarily the outer plate opens when the compressor is running at slow speed, when running at intermediate speed two plates operate, and at full speed all valves are open. The parts making up a complete valve are assembled and held together by a nickel-steel stud and castle nut, and when this nut is tightened in place it is held by the cotter pin.

As shown in Fig. 2, the construction of the inlet valve is similar to that of the discharge valve. It differs in that the keeper is thinner and the springs have lighter tension. On account of this difference in thickness, inlet

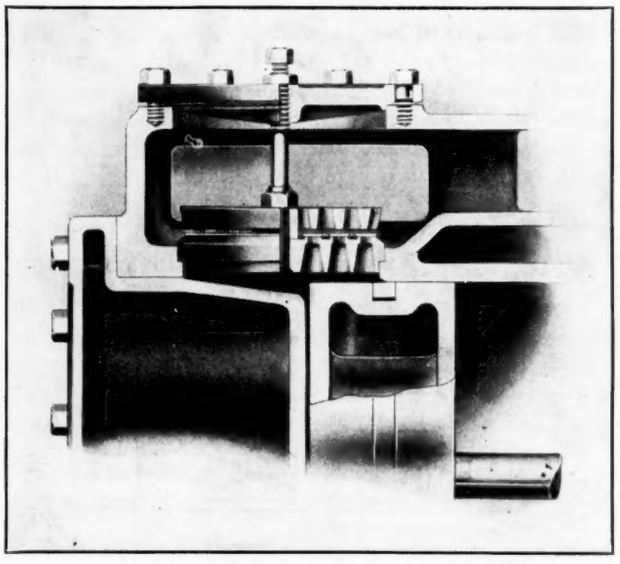


FIG. 3. POSITION OF VALVES IN AIR CYLINDER

and discharge valves cannot be reversed. The spring tension on the inlet valves is light in order to derive the full benefit of the various openings of the different plates when the piston speed is changed. For example, with an inlet valve of the size shown herewith, the spring tension is so calibrated that the outer plate opens with a pressure of but ¼ oz. per sq.in., while 1 oz. will open the intermediate plate and 2½ oz. the inner plate. The valves are said to be noiseless in operation, and their location in the cylinder is convenient for examination or

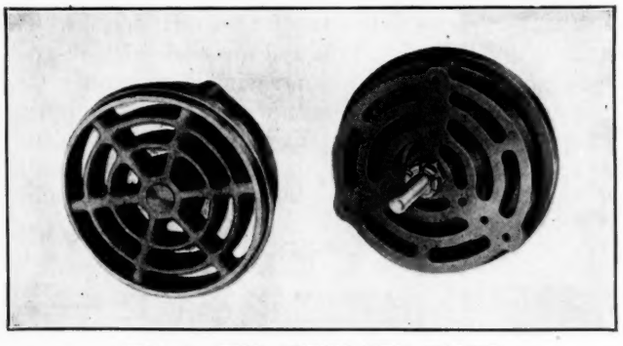


FIG. 4. THE "SIMPLATE" VALVE

repair, as indicated in Fig. 3. Top and bottom views of the valve are shown in Fig. 4. It is equally suited to high- and low-pressure work and requires no lubrication. A feature worth noting is that all valve parts are interchangeable.

To True an Oilstone, take a piece of soft pine board of any thickness, about 8 in. wide and 3 ft. or 4 ft. long. Lay it on a bench and fasten it with a handscrew or other clamp. Put on some clean, sharp sand screened about as fine as that used for plastering work. Use no water, and rub the stone back and forward over the board in sand. This will give a flat surface to the stone in a short time. Care should be taken in moving the stone on straight lines, so as not to give the stone a warped surface. The board can be saved by boring a hole in one end and hanging up out of the way. If a fine surface is wanted, a finer grade of sand or sandpaper may be used to finish with.—"Mechanical World."

Buhne Fibrous Babbitt Packing

The Buhne fibrous babbitt packing is composed of long, fine fibers of composition metal for steam, water, oil and ammonia. For each purpose a different alloy is used. That for steam will withstand a pressure of 200 lb. without fusing, and owing to the composition of the metal it is practically self-lubricating. The hydraulic packing for water and oil is made to stand a temperature of 150 deg. F.; it is not made for steam. The ammonia packing

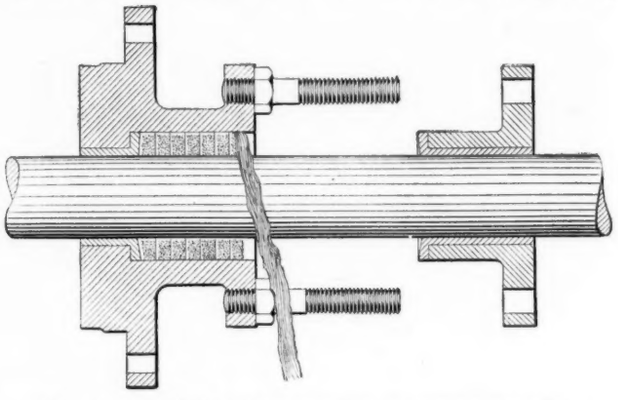


FIG. 1. PACKING APPLIED TO A STUFFING-BOX

is of still another composition and is not suitable for either steam, water or oil.

The illustration, Fig. 1, shows how the packing is applied to a stuffing-box. Each layer of fiber is jammed in place and compressed hard with the gland.

When the rod is worn (see Fig. 2), with space between it and the stuffing-box, the packing can be made to hold tight by inserting split metal rings *A* that fit snugly on the rod. One is placed at the back of the stuffing-box and the other next to the gland, as shown.

This packing, made by the Buhne Metal Packing Co.,

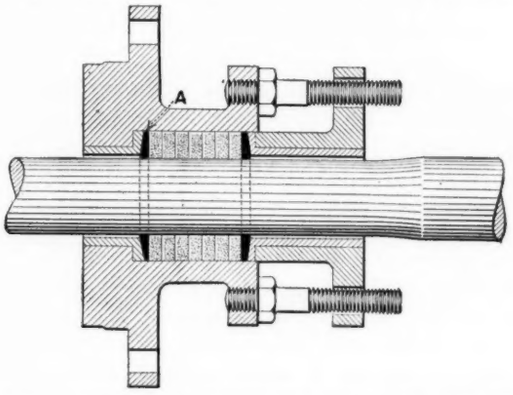


FIG. 2. WORN ROD, BOTTOM RINGS AND PACKING IN STUFFING-BOX

93 Nassau St., New York City, is suitable, in the steam composition, for packing valve stems on steam lines, Corliss valve stems, etc.

For Welding Steel to Iron make a flux compound consisting of iron or steel filings 100, salammoniac 10, borax 6, balsam of copaiba 5. The steel should be heated red, carefully cleaned of scale, the composition spread on it, and the iron applied at white heat and welded with a hammer. In the case of welding steel to cast iron, the steel, after being shaped to correspond to the cast iron, should be heated cherry-red and then have borax applied to the surface. Then both steel and cast iron should be heated to welding heat, and strong pressure applied.—"Mechanical World."

Making a Chemists' Balance

By F. W. Salmon

SYNOPSIS—Since the publication of the coal analysis lessons of the Engineers' Study Course, which appeared in "Power" some time ago, many inquiries from readers as to where they could obtain chemists' balances have been received. These requests, some of which have been published, have called forth the following article, which clearly describes how such a balance may be cheaply and easily constructed.

For an engineer to carry out his work most efficiently or pursue his home studies most effectively, it is necessary to have a chemists' balance. This is rather expensive, as a balance that will weigh as accurately as the one here described cannot be bought new for less than fifty dollars, and it is rarely that one sees a second-hand balance for sale. A set of weights in a glass-covered case, suitable for most work, can be bought new for about three or four dollars from dealers in the large cities who supply the high-school laboratories with scientific and physical apparatus. Many will prefer to make their own balances, and this can be easily done in a few hours for an outlay of about two dollars.

The most important dimensions are given from the most satisfactory balance that I have made or seen. I prefer hard maple for the base *A* and column *B*, all neatly finished and boiled in paraffin or well shellacked to resist the weather. The beam *C* may be a piece of cedar, preferably hard white cedar ¼ in. thick, 2¼ in. wide and 11¼ in. long when finished, reinforced with pieces well-glued on each side *D*, and with a 1-in. hole *E* bored as shown, into which are fitted the three knife-edges *F*, *G* and *H*, which are made of a small "knife" file, ground smooth, *F* being $\frac{5}{16}$ in. wide by 1⅛ in. long, and the others ¼ in. wide by 1 in. long. These knife-edges may be secured in the beam by using sealing wax with a small soldering iron, or by shellac; I prefer sealing wax, being careful to get each knife-edge equally distant from the central one.

Adjusting the Balance

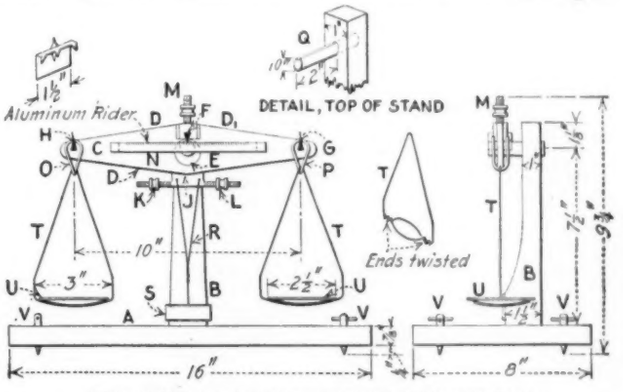
To enable the balance to be adjusted for equilibrium, glue on the lower edge the small piece of cedar *J* on which can be screwed the nuts *K* and *L*, taken from an old dry battery. To permit adjustment of the sensitiveness of the balance, fit the dry-battery nut *M* on the small vertical piece of cedar on the top of the beam in the center over the knife-edge. For the rider, fit the celluloid millimeter scale *N* on the side of the beam by means of two small posts at the ends of the scale. Scales of white celluloid $\frac{1}{32}$ in. thick by $\frac{11}{16}$ in. wide, graduated on one edge to 150 mm. can be had for about five cents each. Re-mark the millimeter scale, commencing with naught at 13 cm. and running to ten at 3 cm.; thus you will have the hundred divisions without the rider's interfering at the ends. The hangers *OP* should be of hard steel-spring wire, 16 to 14 B. & S. gage. I prefer to make and fit these soft and then harden them in a gas or lamp flame so that the knife-edges will never wear into them. They should be of a good size, as shown, so that there cannot be any touching or friction except at the knife-edge.

Assembling the Balance

Assemble the beam, knife-edges and hangers (leave off the rider-scale and the nuts) and boil them in paraffin wax or varnish them, to prevent atmospheric changes affecting the balance too much. When cold, clean off the surplus paraffin with a scraper and cloths wet with mineral benzine. Remember that benzine is inflammable.

The beam is carried by the column through the piece of round steel *Q*, shown detailed. This piece of steel has a small groove cut out or filed along its upper side with a triangular saw file or other tool, to form a seat for the central knife-edge *F*, and set to give the latter freedom through the required arc of motion.

The pointer *R* is made of two pieces of No. 20 B. & S. aluminum wire, twisted to give rigidity and at the lower end, or point, hammered thin to enable a fine reading to



CHEMISTS' BALANCE WITH DIMENSIONS

be taken, so that while it swings close to the scale *S*, it can never touch it. The lower pointer scale *S* is a 2-in. offset scale such as used by surveyors in making maps, and may be bought at draftsmen's supply houses for from 25 to 50c., according to material, and can be had in almost any scale of division desired. I generally prefer 10 per inch.

The suspenders *TT* are pieces of No. 18 B. & S. aluminum wire passed through the hangers *OP* and bent and twisted together at the bottom so as to form seats for the pans without soldering. The pans *UU* are watch crystals bought of the high-school supply houses and cost about 40c. a doz. if plain—that is, not ground to counterpoise each other. If you desire such glasses ground to counterpoise each other they will cost about 50c. a pair. I use the plain glasses and counterpoise with the nuts *K* and *L*, being careful never to change the right-hand pan to the left-hand suspender.

To insure the base being level, use a 15c. two-way level from a photographic-supply store. After leveling the base with the leveling screws, secure the two-way level on the base near the column with screws and paper shims so that it shows level in both directions; thereafter the position of the base can always be checked by the attached two-way level.

The leveling screws *V* are No. 14-gage wood screws, two inches long with their heads cut off and pins put

through their bodies, screwed through bored holes in the base and set on small metal cups or glass, so that the points will not settle in and quickly throw the base out of level. I prefer four of these leveling screws instead of three as used by some makers, as with four properly adjusted to a bearing there is much less danger of accidentally tipping the base and spoiling a weighing or upsetting the fine adjustments of the instrument.

Making the Rider

To make the rider, I carefully adjust the balance by the nut *M* with the beam level and the pointer in the center of the scale *S;* then I put in the left-hand pan the weight that I wish this rider to represent. With the rider at the 100-mm. point on the scale *N*, the beam should be in balance with the pointer in the center of scale *S*. Balance the beam again with the rider at zero millimeters on *N* scale with the weight removed from the left-hand pan. This is the most tedious part of the adjustment, but can often be done in an hour, and when it is done, of course any weight in the pan that will balance the movement of that rider one millimeter on scale *N* will equal $^1/_{100}$ of the weight in the pan used in making the rider. Thus if we had used a 100-mg. weight ($^1/_{10}$ gram) in making the rider, and to balance something in the balance requires the rider to stand at 55 mm. on scale *N* without any weights in the other pan, we find the material weighs 55 mg., because the rider at the 100 mark balanced 100 mg.; therefore each division must be the equivalent of 1 mg. It is a convenience to have several riders, but two are generally enough. To avoid changing their weight never handle them with the bare hands, but with ivory- or celluloid-pointed forceps.

From some years of experience with such balances I prefer not to complicate them with unloading devices such as raising and lowering support, but to have two small blocks of soft-wood, treated with hot paraffin and well cleaned afterward with benzine, about 2x3 in. by ¾ in. thick, to slide easily under the pans, and so support them when I wish to change the weights, etc.

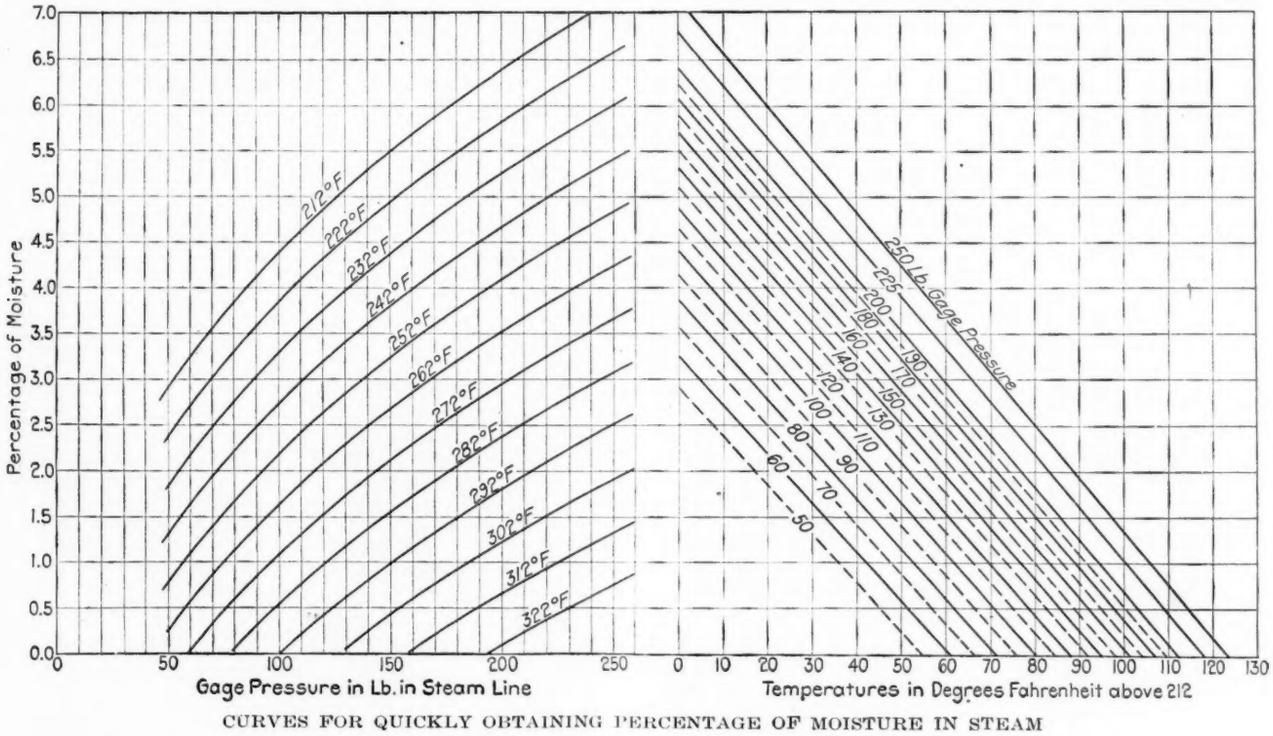
The riders are small pieces of aluminum cut with scissors to the shape shown and bent to hook over the scale *N*, the fine point projecting downward in the front being used for reading its position on the millimeter scale *N* and the upper point at the back for sliding it along the scale or handling it with the forceps. This last point is made by cutting two sides of a triangle in the back and bending the piece upward on the third side. Of course the weight of the rider is adjusted by filing the lower edge.

A good balance carefully made like this should have a glass case to keep it free from dust and prevent drafts interfering with weighings. The case is a simple matter, and may be made of ordinary window glass.

Diagram for Throttling Calorimeter

By R. S. Bayard

The throttling calorimeter is not accurate with steam containing more than 3 per cent. moisture. It is therefore essential to know, at the start of any test, if the moisture is more or less than 3 per cent. The curves illustrated give the percentage of moisture when the steam pressure and the calorimeter temperature are known.



CURVES FOR QUICKLY OBTAINING PERCENTAGE OF MOISTURE IN STEAM

Suppose the steam-gage reading is 110 lb. and the thermometer 252 deg. F. The left side of the diagram shows, at the intersection of the vertical line for 110 lb. pressure and the diagonal curve for 252 deg., a moisture of 2.4 per cent., and the instrument is therefore within its working range.

By this method the results are obtained quickly and without the use of steam tables and slide-rules. The curves have been plotted both on a pressure scale with different temperatures (left side), and on a temperature scale with different pressures (right side).

The Polar Planimeter

By S. B. Redfield*

As an instrument for measuring areas, especially of indicator diagrams, the polar planimeter is familiar to the majority of the readers of *Power*. It is unlikely that all of them are familiar with the theory of its operation. In the proof of this theory we must assume that the area to be measured is made up of extremely small parts. We can assume, for instance, that the area is a rectangle made up of a large number of very narrow rectangles. We could then, if we had time enough, run our planimeter around each of these slim rectangles in turn, get its area, and finally add the areas of these little strips to get the total. During the process of going around each little strip, we can imagine that the strip is so narrow in comparison to the length of the planimeter arms that the arms and wheel, which swing up and down while traveling the long way of the strip, remain practically parallel to themselves during the sidewise movement. Also, for the present we will assume that instead of running the usual tracing point around the edges of the area, the wheel itself is used as the tracing point.

Thus, in Fig. 1 the height AB is of measurable length, but the width BC is extremely small. When the wheel moves from position A to E and then to B, its axis swings through the angle AOB, which is the same as angle KBC, or X; but in moving from B to C the distance is so short that the positions BO and CR of the wheel axis are practically parallel. In traveling from A to B the wheel rotates and registers on its dial, but on the downward journey from C to D the wheel will be turned back, so that the record from A to B will be blotted out. The only permanent record of the wheel movement must be obtained along the path BC, for along the path from D to A the wheel slides without rolling, and there is no record. In moving along BC the wheel will partly roll and partly slide, but the only record will be that caused by rotation. This same record could be obtained by sliding the wheel along its axis from B to K, and then rolling it at right angles along KC. Therefore, in traveling completely around $ABCDA$ the only wheel record obtained is equivalent to the distance KC.

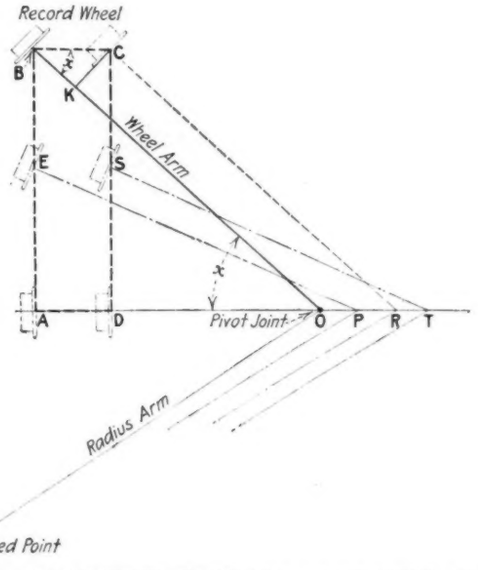


FIG. 1. PLANIMETER POSITIONS IN TRACING AREA

But as KC is BC sin X, and sin X equals $\frac{AB}{BO}$, the distance recorded is $BC \times \frac{AB}{BO}$. If the radius of the wheel rim is r, and if it makes n revolutions along KC, the distance covered, or the record obtained, is $2\ \pi rn$, or $KC = 2\ \pi rn = \frac{BC \times AB}{BO}$. Since the product $BC \times AB$ is the required area of the rectangle, record $KC = 2\ \pi rn = \frac{area}{BO}$. We then can write, area $= 2\ \pi rn \times BO$, or, as it usually is written, area $= 2\ \pi rnl$, where l is the length of the arm.

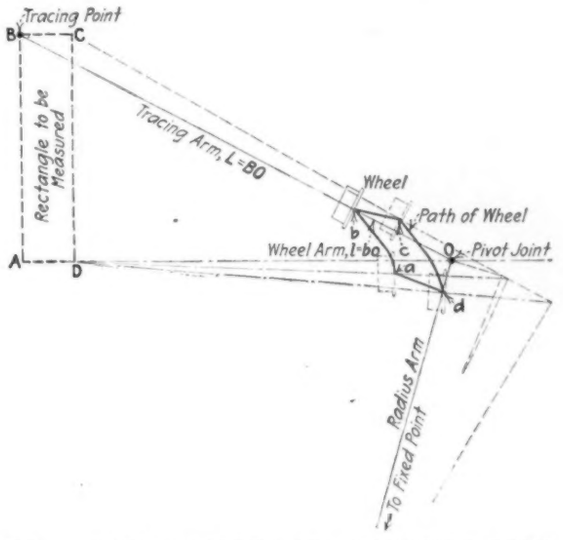


FIG. 2. PATHS COVERED BY PLANIMETER POINT AND WHEEL TRACING RECTANGLE

In the practical instrument (Fig. 2) the tracing point is on the extreme end of the arm carrying the wheel. The tracing arm and the arm reaching from the fixed point are joined at the pivot O. Now, if the tracing point follows around the area to be measured, the wheel will travel around a smaller area of its own. This is not the same shape as the area inclosed by the tracing point, but the distance traveled by the wheel is directly proportional to the travel of the tracing point proper, in the ratio of the arms Ob and OB, or $\frac{l}{L}$. The larger, or tracing point, area will then be $2\ \pi rnl \times \frac{L}{l}$ or $2\ \pi rnL$, where r is the radius of wheel and L is the length of arm from pivot to tracing point. But as L is constant (at least in the ordinary instrument), the tracing-point area is directly proportional to the movement of the wheel and the latter is marked in units of area.

This proof assumes, of course, that the area to be measured is a rectangle which may be divided into a large number of extremely narrow strips, each in itself a very thin rectangle. However, the proof applies equally to any area, an indicator diagram, for instance. In Fig. 3 is an indicator diagram divided into a large number of narrow strips. If these strips are made narrow enough, each will be practically a rectangle. The curved lines may be considered as composed of a series of tiny steps, each step forming the horizontal end of a thin rectangle. If each

*Engineer of tests, Ingersoll-Rand Co., Phillipsburg, N. J.

thin area were gone over separately with the planimeter, the tracing point in going up the left side of one rectangle would be neutralizing the downward trip on the right side of the previous rectangle. The trips along the dividing lines may therefore be omitted, and the wheel will register the true area if the tracing point takes in only the outer lines of the diagram.

So much for the theory of the planimeter; now for a few remarks as to its proper use. The kind of surface on which the planimeter wheel travels has much to do with the accuracy of the readings. On a slippery surface, such as tracing cloth, the wheel slides when it should roll and this results in a continually decreasing reading. Ordinary drawing paper is too rough. Good bond letter paper and bristol board, when stretched absolutely flat and tight, give consistent and accurate readings. If the surface is loose the wheel will push up a wave in the paper, which means a false reading.

The planimeter can be easily calibrated by tracing a known radius. Take a strip of cardboard and put a pin through one end into a drawing board. In the other end

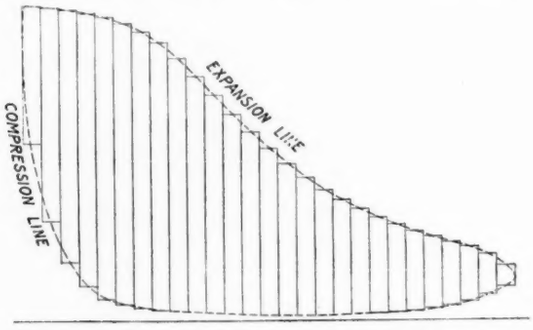


FIG. 3. INDICATOR DIAGRAM DIVIDED INTO RECTANGLES

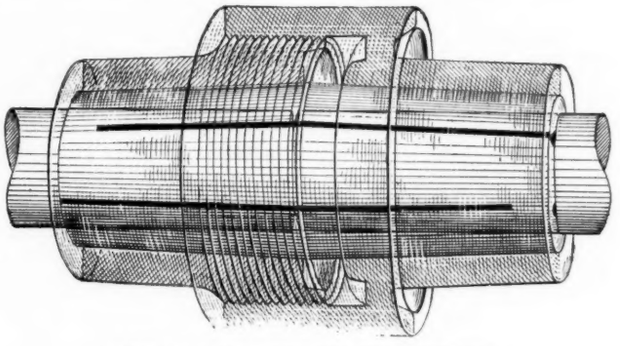
make a hole just large enough to take the tracing point, and using the cardboard strip as a radius go round and round in a circle with the tracing point, taking wheel readings at each rotation. If the wheel travels on a suitable surface the areas recorded will be identical. To see if the instrument gives the true area, measure the diameter of the circular track left by the tracing point. This diameter can easily be measured to $^1/_{100}$ of an inch and the area calculated closely. The calculated area should either agree with the wheel readings to ½ per cent. or else the instrument is out of adjustment.

It is better to take the test radius at random and measure the actual diameter of the track than to make a radius piece of an exact length. Sometimes, a brass square of a known size is used for this calibration. However, this is a poor method, because the thickness of the tracing point makes the traversed area considerably larger than the area of the brass square. The instrument is also calibrated by drawing a square or describing a circle and following the line with the tracing point by hand. This is an excellent way of testing the operator, but does not differentiate his personal error from the error of the instrument and of the surface on which the wheel travels. The latter is most important to test. One of the worst practices with a planimeter is to follow a straight line with the aid of a straight-edge laid along the line. If this is done, and the straight-edge is a hair above or below the true line the total error may be a very appreciable area. It is far better to follow the line by free-hand, shaky though it may be, because the errors of the hand tend to equalize themselves on each side of the line. Such equalization is, of course, out of the question if a straight-edge is used. For experimental work properly done, all of these precautions are well worth observing or else false or inconsistent, and sometimes unexplainable results may be obtained.

Rothenbucher Compression Shaft Coupling

A new design of compression shaft coupling that has neither nuts, bolts, keys nor screws has been developed by the Coronum Equipment Co., 110 Fulton St., New York City.

The device consists of three parts, a sleeve and two coupling sections. The sleeve is made tapering on the outside and bored to fit the shaft. It is slit, alternate slits extending from each end nearly to the other, to



DETAILS OF THE SHAFT COUPLING

give it a clamping grip on the shaft. One of the couplings has a shoulder threaded on the outside, the other is threaded on the inside, and both are bored with a taper to fit that of the outside surface of the sleeve.

When applying the coupling, the two outside pieces are slipped on the shaft and the sleeve is placed with its center in line with the ends of the shafting. The two outside parts are then placed on the sleeve, and when the threaded portions engage the two sections are drawn together by turning the outside member with a spanner wrench. As the coupling is drawn in on the sleeve the latter is forced against the shaft with sufficient gripping pressure to carry the load.

Long Continuous Run of a 500-Kw. Turbine

A remarkable record of continuity of service in power-plant operation has been reported by the Quincy Market Cold-Storage and Warehouse Co., at Boston.

Mr. Fairbanks, the chief engineer of this company, reports that they have had in operation a 500-kw. Westinghouse-Parsons turbine that has been carrying load continuously for two years and eight months without the steam being turned off at the throttle. Recently they decided to shut down the turbine to give it an inspection which showed that the machine was in good condition and it was immediately put back into service.

For articles treating of the equipment and methods in this plant see *Power*, Dec. 8, 15, 22, 29, 1914, and Jan. 5, 1915.

Editorials

The Unappreciative Superior

The inconspicuous duties of the operating engineer lead almost automatically in many cases to a sense of not being appreciated by one's superior. Modest efficiency sows seeds of confidence wherever real merit is in demand, but sometimes it takes those seeds a good many seasons to flower forth in the shape of a salary increase. Young engineers, especially if they have been fortunate enough to have obtained a technical education at considerable cost of time and money, sometimes become weary on account of slow advancement, and here and there tend to slack off a bit in that sum total of effort which represents their real efficiency in the service of their employers. It is easy in such instances to develop scattering outside interests and to look upon the daily routine as a necessary evil that will presently give place to something better.

The remedy for this kind of discouragement is precisely the same, whether one is working for a superior who is, or one who merely seems to be, unappreciative. In a nutshell, increased effort to make a perfect record on the job and then to strive toward superlative accomplishment is the policy to adopt. In a plant where the engineer meets with no appreciation, one of the first opportunities for slacking off comes in the field of maintenance. Little defects in equipment are perhaps allowed to exist longer than would be the case were the management of a different caliber; less pride is taken in the appearance of the station, suggestions and betterment schemes are passed by, and very likely not so much care is exercised in keeping the log sheet. Disregard of one's personal appearance tends to creep into a plant where the staff is discouraged or dissatisfied, and it is only natural and human that volunteered extra effort should gradually diminish toward the zero line—that dead level of mediocrity whereon so many promising careers are checked because of insufficient will-power to rise to higher values.

The meanest boss that ever refused to back up a capable engineer and then damned him behind his back to the manager as an inefficient cog in the organization machine should be given the same full measure of professional, efficient service that would cheerfully be accorded a square-minded superior. Personalities have no place in the conduct of a plant, and as long as an engineer is on the payroll, the installation is entitled to the best there is in him. Any other course on his part is virtually committing professional hara-kiri, for it provides evidence that such a boss can and generally will use with telling effect when the question of a change or a recommendation comes up. It ought to be the everlasting joy of the engineer that his profession is founded on the great rock of scientific truth, a fact which means that in the long run, whims, graft, prejudices and the whole brood of incompetent and dishonest ideas and practices by which mean and little men appear to thrive must go down into the pit.

The obligation to put forth one's very best energies in serving a thankless superior by no means implies that the engineer must keep up this program year in and year out without trying to better himself elsewhere, if he cannot gain recognition locally. He needs, however, to lay some solid foundations before making outward moves in this direction. He will do well to begin a system of private records of plant performance under his direction, showing in black and white what the station has been doing since it came under his care. If the cost of production has been decreasing per unit of output, or if heavy investments in additional equipment have for the time being been avoided, through his enterprise, let such points go into the book. Then, when the time comes to demonstrate where he has made good, he can do it without trying to rely upon his memory alone; and it is not difficult to imagine occasions where a neat loose-leaf record of this kind will count for more with the manager or prospective employer than all the generalities which the unsatisfactory boss can summon against him.

Even in plants where the owners refuse to spend the money to improve the efficiency in any but the most obvious ways, there will be enough troubles to minimize and patch up and enough opportunities to practice engineering ability on "the old junk-pile" to supply convincing evidence to the man qualified to judge. Then, when the outside offer comes, the engineer can go to his superior with a sense of power in his abilities and accomplishments which will rob the interview of its terrors, and put the issue squarely up to the two men to consider together on the same plane, assuming that the engineer cares to remain upon a new and better basis. Often on such occasions appreciation long concealed bursts its bonds and results in a new and improved relationship for many years to come.

Increasing the Efficiency of the Gatekeeper

A gatekeeper is essential at many city stations, particularly where a considerable yard surrounds the power house. Such an employee, if properly trained and supported, can be of advantage in several ways. For the best results, however, more must be done than to install a superannuated employee in a shack scarcely fit for a henhouse and tell him to admit only persons with duly signed credentials.

It should not be necessary to enlarge upon the importance of providing the gatekeeper with a telephone to communicate with the station officials; yet a city plant of over forty thousand kilowatt rating was visited in which this inexpensive convenience was absent. As the gatekeeper's house was about a hundred yards from the plant, the engineer in charge could not be reached without first securing a pass at a down-town office nearly two miles away; and this despite the fact that the visitor had been admitted on a pass only a short time before to the innermost recesses of the switchboard gallery. In this case the want of a telephone caused a delay of twenty-four

hours, since it was not feasible to get the formal permit that day. It is always desirable to identify and pass upon visitors, but often the engineer could properly assume the responsibility of admitting someone and thus avoid delay, if he could only be reached by telephone from the gate. In the case in mind, no signature absolving the company in case of accident was required on the pass as finally issued, and therefore there was no legal excuse for the difficulties encountered.

Long-hour service is a part of the gatekeeper's job, and adequate heating facilities, with enough artificial light to permit reading in comfort, should be provided. Unless land is exceptionally valuable, a fair-sized gatehouse is worth the cost, since it affords room for waiting for cars in inclement weather, permits the transaction of some of the clerical side of stock and supply keeping, enables a gatekeeper's log to be handled freely, and on occasion affords accommodations for a cot bed, stretcher and first-aid set, with perhaps a basket or two of emergency line repairing tools and supplies, time clock, fire-alarm auxiliary-box connection, fire extinguishers, local time tables and other conveniences. Certain classes of repair work may even be handled efficiently in the gatekeeper's lodge.

The power plant needing the services of a gatekeeper can take a leaf from the book of the large industrial establishment in this respect and make the entrance office a bureau of information, the advantages of which are but little realized in cases where only a primitive type of lodge is utilized and the gatekeeper's qualifications are only ability to take up passes and unlatch the gate for authorized passing.

Plant owners or managers might profitably show more interest in the work of these often necessary, though humble, employees.

Avoiding Equipment Prejudices

The more experience an operating engineer acquires in a plant provided with satisfactory equipment, the easier it becomes to favor the particular makes of machinery comprising the installation when extensions or other improvements are in order. A kind of obsession sometimes exists in the mind of an engineer that only certain makes of boilers, engines, generators, etc., are desirable for the best service. It is good to see this attitude giving way to broader and more intelligent points of view. Early training in the shops of a particular manufacturer sometimes inclines even a consulting engineer toward one make of machinery, so it is not surprising that the mastery of certain makes of apparatus, or admirable service from some types, or unfortunate experiences with others, now and then tend to prejudice the operating man's opinions.

An open-minded attitude toward equipment should be maintained. Unsatisfactory previous experiences with products of particular makes naturally hurt their chances of being installed, where the engineer's advice carries due weight, but, granted the soundness of a "show me" policy, the engineer overreaches himself if he assumes that because a certain machine failed once to make good under his observation, the manufacturer has ever since stood still. Possibly the troubles formerly experienced have put the manufacturer on his mettle, aroused the combative enthusiasm of his staff of designing and production engineers, and led to improvements that yield higher efficiency in service than does the apparatus favored by the operating man. Claims of this nature should not be taken for granted, but they at least deserve investigation.

Without enumerating all the points to be considered in selecting apparatus for plant service, it is clearly fundamental to make comparisons on the basis of cost, capacity, efficiency, attendance, space requirements, simplicity, safety and other features, including guarantees, extra cost of handling, dissimilar spare parts and facility of maintenance. Where the plant owner insists on uniform makes of equipment, nothing can be done but order duplicates or similar designs to those in service; but where the engineer is given a real voice in selection—as he should be—he should never fail to investigate the improvements that may have been made in competitive apparatus, study these with the keenest criticism, and if they appear better adapted to his employer's service with a strong guarantee to boot, he should make his findings accordingly.

Engineering and Business Training

The training of an engineer is essentially along the line of exactness, or not taking chances, and that of the business man is largely when to take chances, large or small, according to the nature of the enterprise. It therefore requires a dual nature or training to develop both speculative risking and mathematical exactness in the same man at the same time. For example, an engineer asks for a price quotation by wire, and having no means of knowing whether the business will go to this particular firm or not, his sense of justice prompts him to add, "wire collect." The reply is received, paid of course by the business-wise dealer, and eventually the deal goes through.

Estimating that this small order, in which the cost of the telegraphic reply amounted to two per cent. of the total purchase price and perhaps eight or ten per cent. of the net profit, could be filled as well by any one of ten competitors, the odds, disregarding the human element or psychological effect, against which the dealer played may be seen. Would the engineer accept such odds against him? In an engineering proposition, certainly not; as a business deal, probably not, especially if his engineering training predominated. He should learn when to take chances and when not to—when to be a business man and when to be an engineer.

The following so well expresses our sentiments regarding material relating to the steam plant that we have borrowed it from an exchange. The original source of the poem is unknown.

SEND IT IN

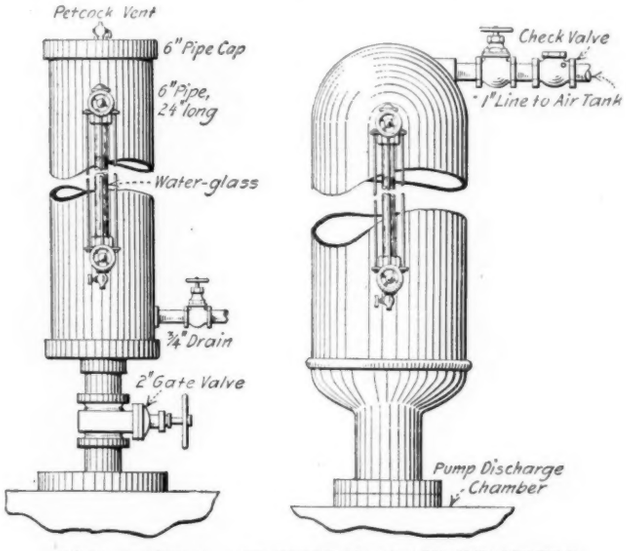
If you have a bit of news, send it in.
Or a joke that will amuse, send it in.
A story that is true, an incident that's new,
"We want to hear from you," send it in.
Never mind about your style,
If it's only worth the while, send it in.
Will your story make us laugh? send it in.
Will it make a paragraph? send it in.
If some good your words can teach,
If some distant reader reach,
If you have a glowing speech, send it in.

A flexible coupling that will work on shafting that is out of line may help some, but it helps more to have shafting as it should be—straight and true.

Correspondence

Water Level in Air Chambers

There are two opposite conditions under which it is necessary to provide means for regulating the water level in pump air chambers: The first, as referred to in the issue of Sept. 7, page 351, wherein excessive air accumulates probably by reason of air leakage into the suction under a considerable degree of vacuum and must be gotten rid of as described; the other, where the suction line has no air leaks and slight lift or perhaps a supply under some pressure, so that no air gets in with the water, and where the discharge pressure is considerable, in which case the water would tend to absorb part of the air; besides possible slight leakage about the air chamber would reduce the air to such an extent as to require means



FIGS. 1 AND 2. AIR SUPPLY TO AIR CHAMBERS

for putting air into the chamber rather than for withdrawing it.

The function of an air chamber on a pump or any line conveying a fluid under irregular speed or pressure is to take up the shock at the end of a pump stroke or at other change in velocity, and the air chamber should be of proportionate size and should at all times contain sufficient air to accomplish this result. On small pumps air chambers are seldom fitted with glass gages, but on large ones they are, and these connections should be kept free from air leaks and in good condition, so as to show the true water level in the air chamber. There is seldom any provision made to force air into the chamber of a small pump should it become filled with water, so that the chamber will gradually fill with water that cannot be drained out while the pump is running.

At one plant we had a motor-driven triplex pump delivering water to a tank on the roof, and the discharge head was about 120 ft. After the pump had run for about 3 hr. the discharge pipes would begin to vibrate badly, so that the pump had to be shut down and the air chamber drained of water. To avoid this shut down we connected up the rig shown in Fig. 1 to replace the copper chamber. When water accumulates until it comes near the top of the glass, the 2-in. gate valve is closed and the vent cock and ¾-in. drain valve opened. When the chamber is empty the vent and drain are closed and the gate valve is opened again. This provides a good air cushion and prevents water hammer in the lines, and the pump does not need to be shut down.

In another plant, in an office building, four large pumps used for hydraulic-elevator service and working against 150-lb. pressure had large air chambers that were connected to the air-pressure tank, as shown in Fig. 2. Whenever the water came up to within 3 in. of the top of the glass, the valve in the air line was opened and more air supplied until the water had reached the bottom of the glass.

It was of course necessary that the air pressure be higher than the pressure in the pump.

Covington, Ky. GEORGE A. WEINDEL.

Miter Coils for Exhaust Steam Heating

In the Oct. 12 issue, page 506, Mr. Solomon makes the statement that while return-bend coils are satisfactory for live-steam heating, they will not do for exhaust heating and that miter coils must be used in the latter case.

In general, heating coils made up of pipe may be divided into two classes—return-bend, or "series," coils and "multiple" coils, the latter consisting of two headers, or manifolds, with a number of pipes between them. Multiple coils may be again divided into what we may call "corner" coils and "miter" coils, depending on how they care for expansion. If the pipe coil can be arranged so as to turn a corner of the building, both manifolds may be set vertically and the elbows located at the corner of the room. This would be called a corner coil. If, however, the coil must be entirely on one wall, one end of the coil must be turned up the wall and its manifold will then be horizontal. This would be a miter coil. The same manifolds and right- and left-hand elbows would be used in either type.

Where the steam-distributing mains are overhead, the corner coil is preferable to the miter coil, owing to the fact that its control valve is more easily accessible from the floor. Steam must be admitted at the highest point of the coil, and in case of the miter coil this is too high for the valve to be easily reached. For ordinary factory-heating coils I use 1¼- or 1½-in. pipe with cast-iron branch tees. The latter are made for the purpose and can be obtained in any desired size and with any number of branch outlets. For 1¼-in. pipe the branch tee should be 2½ in. in the run, while for 1½-in. pipe it should be 3 in.

One point was omitted in Mr. Solomon's article; namely, that exhaust-heating systems are nearly always installed with vacuum returns, the vacuum being produced by a

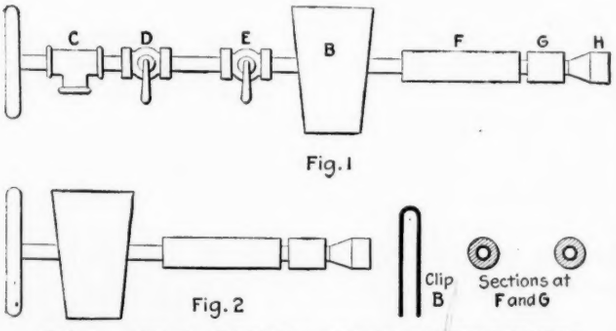
vacuum pump, usually located in the power house. Such being the case, the air cock is not needed, since the vacuum pump takes care of both air and condensate. The outlet of the radiator, at the bottom, is bushed down to ½ or ¾ in. and connected to the vacuum return line through some form of vacuum valve, whose function is to pass the condensate and air, but hold back the steam. In all pipe coil radiators pipes should be pitched in the direction of steam flow.

T. B. HYDE.

Cleveland, Ohio.

Outfit for Testing Surface-Condenser Tubes

The illustration shows the parts of an apparatus used in testing the tubes of surface condensers for leakage. At this plant the cooling water from the river is at all times muddy and more or less contaminated. It was known that there was leakage, but through which tube or tubes could not be determined by the usual pressure and vacuum tests from outside the tubes. It was therefore necessary to test each tube from the inside with water pressure. No attempt has been made to draw to scale,



FIGS. 1 AND 2. DETAILS OF RIG TO TEST TUBES

the intention being only to indicate the several parts, their form and relative positions.

Two condensers, each containing about 3,000 tubes, were tested. It was important that the apparatus should be made easy to manipulate and move from tube to tube. A method for determining and giving notice when a leaking tube was found was devised by posting a colored "husky" in the exhaust well just beneath the condenser, with a string attached to an electric-alarm. Results proved the efficiency of the apparatus and the semi-automatic alarm.

Pipe Fig. 1 is made up of ¼-in. iron pipe. At *C* water is supplied at about 35 lb., controlled by the cock *D; E* is a three-way cock by which the pressure is released and the water drained off; *B* is a U-shaped chip; *F* is an iron sleeve. A soft-rubber plug *G* is forced on to the cone-shaped rigid head *H*, thereby expanding *G* against the walls of the condenser tubes, forming a water-tight joint. The opposite end of the tube was closed, as shown by Fig. 2, which duplicates Fig. 1 in construction except the water connections, its use being only to seal the end of the tube. By the use of two sets of tube stoppers, each tube was under pressure for about thirty seconds, while the other tube was being drained and the rig changed to another tube. The work progressed regularly and rapidly, with once in a while a "mis-lick," resulting in a good drenching of the offender.

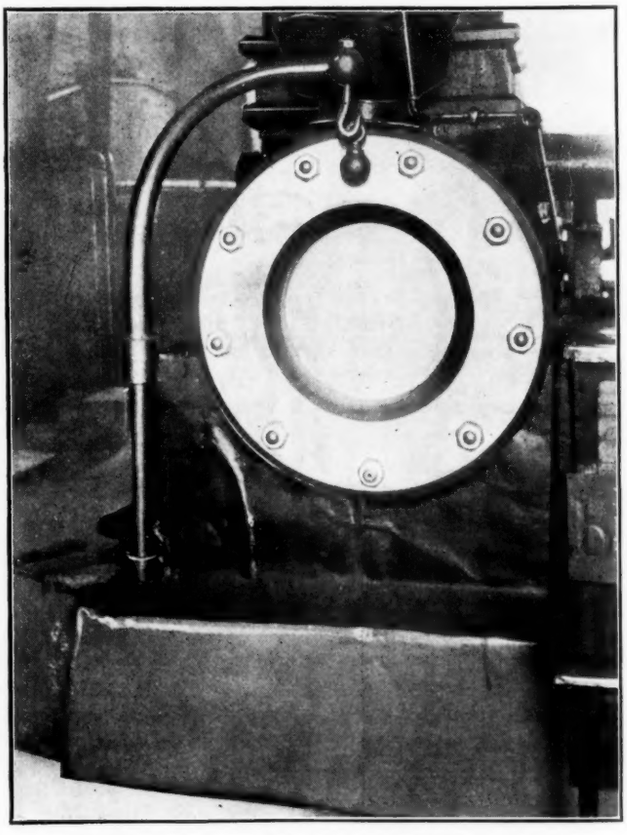
In the first condenser only one leaking tube was found, with an almost invisible split in it about eight inches long, a most insignificant-looking fault with no pressure on the inside of the tube. However, upon being taken out and afterward tested, it was easily seen that sufficient water could leak there to cause a considerable contamination of the condensate. In the second condenser six defective tubes were found. It was very difficult to realize that with the repeated and careful tests previously made in other ways, those leaking tubes could not be detected. The test was particularly important in that it demonstrated the fallibility of vacuum and pressure tests from the outside of the tubes. It also determined the treacherous character of the tubes under test, some of the faults being of most peculiar form.

JUNIOR PARRISH.

Savannah, Ga.

Cylinder-Head Davit Crane

I was interested in the article by F. W. Salmon, page 481 of the Oct. 5 issue, entitled "A Cylinder-Head Davit Crane," particularly because I had but a few days before



PERMANENT CYLINDER-HEAD DAVIT CRANE

run across one in an engine room at Parkersburg, W. Va. It is illustrated herewith.

The davit is attached to the engine frame as shown, the lower end resting in a socket and a bearing being provided at the top of the engine frame. The outer end of the davit is made to carry a hook and is so proportioned that the center line of the hook comes in line with the center line of the eye-bolt that is screwed into the cylinder head.

When the cylinder head is to be removed, the hook is passed through the eye-bolt and the nut on the top of

the davit tightened until the head is free to be swung from the stud-bolts.

This device came with the engine from its makers and was not attached by an engineer who realized the convenience of the arrangement. R. O. WARREN.

New York City.

Condenser Was Full of Liquid

Having had trouble with leaks in an inaccessible submerged condenser, which, together with repairmen's time, loss of ammonia and interruptions in service, had produced trouble for years, it was decided to install a double-pipe condenser in an accessible place where leaks could be quickly found and stopped.

About a month after starting the new machine it became necessary to add ammonia to the system. A 50-lb. drum was attached and about 40 lb. had been added, when the head pressure started up, the drum was shut off and the system put to work. The head pressure went back to normal. About six hours later the head pressure started up and went up until it reached 250 lb., and as no amount of water would bring it down the assistant stopped the machine. When the chief arrived he started it with the same result. He concluded that the condenser was not doing its duty because it had no condensing surface, being full of liquid ammonia. Then he connected the drum again and drew back some of the ammonia into it.

The drum was placed on platform scales while still attached, and about 15 lb. was withdrawn from the system.

The old submerged condenser would stand an initial charge of 250 lb., while the new one appears to be fully charged with about 40 lb. KAREK TAZELL.

Toledo, Ohio.

Operating an Outlaw Engine

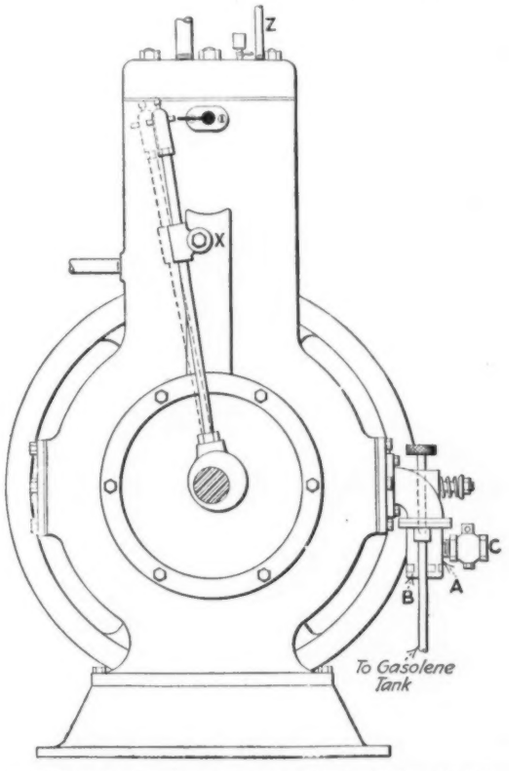
The engine was an 8-hp. vertical of the two-stroke-cycle type and had been purchased several years previously for operating an irrigation pump. However, it had not seen much service as no one had ever been able to make it run for more than thirty minutes.

After spending considerable time and money in ineffectual attempts to operate it, the owner decided to discard it and purchase a four-stroke-cycle machine. The engine had quite a local reputation as a hoodoo, and as it could be bought for the price of scrap, I decided to purchase it and learn the cause of the trouble.

The maker could not be found, but it had apparently been built about 1905, and while the general design as regards size and location of ports, arrangement of details, etc., followed standard practice fairly closely, it was evident that the principal object of the designer had been the production of a low-priced rather than an efficient and economical engine. After looking it over and putting the ignition apparatus in order, an attempt was made to start it, but it was found that while the gasoline was removed from the chamber *A* of the mixing valve by the entering air, little or none found its way into the cylinder, the greater part remaining in the crank case.

As the temperature during the test was low (zero weather prevailing) it was thought that the crank case acted as a condenser and trap and in order that gasoline might reach the cylinder it must be atomized and thoroughly mixed with the air. Accordingly, disks were cut from copper gauze and placed in the bottom of chamber *A*, a sufficient number being used to bring the uppermost above the air-inlet ports *B*. The theory was that the air coming up through the gasoline-saturated gauze must become thoroughly impregnated. As this restricted the air passages, an auxiliary passage was provided by drilling and tapping the chamber for a 1-in. plug-cock *C*.

After adjusting the gasoline and air supply, the engine would start and come up to speed, accompanied by vicious backfiring and crank-case explosions at every few revolutions. This proved to be caused by a late spark, however, as there was no provision for adjusting the timing



INDICATING WHERE CHANGES WERE MADE

while in operation and it could not be started with an advance of over 5 deg. ahead of center. It therefore became necessary to provide some means of adjustment, which was accomplished by placing an eccentric bushing with locking device on the wabbler stud *X*.

The bushing was set to give the tripping-rod the position shown in full lines at starting, and as soon as speed was attained it was turned to give the position shown by the dotted lines. The engine now ran steadily, it being necessary to set the spark nearly 30 deg. ahead of center to obtain the best results. This seemed to indicate slow flame propagation, which I believe to have been caused by the height and shape of the piston baffle, as it formed a very close joint with the cylinder walls and head when the crank was on top center, thus isolating the igniter from the rest of the cylinder at this point in the stroke.

After operating about an hour, however, a squeak and groan which no amount of oil would stop would develop in the cylinder. Investigation showed the jacket oppo-

site the lower water connection to be much hotter than the part adjacent to the connection. It was also found that the jacket occasionally became steam-bound, stopping the circulation.

These difficulties were overcome by placing a perforated baffle directly above the lower connection, causing part of the water to flow to the opposite side of the cylinder. The steam-bound condition was obviated by placing a vent as shown at *Z*. The jacket temperature was now uniform throughout, and the squeaking and groaning disappeared.

It was found economical to preheat the air, this being done by placing a jacket around the exhaust pipe and connecting it to plug-cock *C*. The engine now operates satisfactorily and with a fair degree of economy for this type.

F. W. Robinson.

Albuquerque, N. M.

Central-Station Rate Making

In the issue of Aug. 24, there is an interesting and timely article by Paul J. Kiefer on central-station rate making. The theory appears correct, but the example leaves much to be desired. The demand is based on the individual maxima, which is not correct. It should be based on the demand at the time of the station peak, or take into account the diversity factor.

Mr. Kiefer gives figures for group maxima, but they are not used in figuring the demand charge for the group. According to this, however, the station having a rating of 3,000 kw. would have a load of 4,608 kw., or 53 per cent. overloaded—rather more than good practice would allow.

From figures of the Commonwealth Edison Co., the diversity factor on residences is 4.13, which is quite different from the 0.7 taken by Mr. Kiefer. Using this, the lighting-load group would reduce to about 600 kw. instead of 1,660, as given in the example. Using the same company's data for the others, the commercial lighting would equal 810 kw.; street lighting, 400 kw.; commercial motors, 369 kw.; and wholesale motors, 1,665 kw.—making the maximum station load 3,844 kw., which would give a base for figuring the demand of 3.70, approximately. The group demands would be about as follows: Residence group, 2,120 kw.; commercial lighting, 3,000 kw.; street lighting, 1,480 kw.; commercial motors, 369 kw.; and wholesale motors, 6,170 kw. From these the individual charges can be determined in proportion to their maximum demand.

It will be noted that these figures would make the demand charges much less for the residence group and considerably greater for the others, which is in accordance with justice, because the total cost to the consumers should be in accordance with the power-station requirements. There is, however, a fallacy in this method of figuring, in that it assumes that the cost per kilowatt is the same for all characters of load. This is not true exactly, because it unquestionably costs more per kilowatt to equip a plant to supply a small consumer than it does for a large one, but nothing like the difference usually shown by the central station. This question, however, should be taken into consideration in determining the demand rate. The demand rate has not been figured out completely in this letter, but enough has been said to show the weakness of the example.

So far as energy charge is concerned, it costs more to the central station to supply energy at certain times of the day than it does at others, and it is hardly fair to determine the energy charge at a flat rate, depending on the cost, divided by the total kilowatt-hours.

Henry D. Jackson.

Boston, Mass.

An Unusual Open Circuit

A series motor operating a floor-controlled hoist of about three tons' capacity would work satisfactorily for long periods and then refuse to start. This invariably happened when a load was suspended on the hook. The gears would be pried over by hand to lower the load and the hoist moved to the end of the runway where the motor could be more conveniently examined. Beyond a blackened commutator no open circuit could be found. The commutator would then be sandpapered and the hoist would work satisfactorily for several weeks until the same trouble again developed.

After this had been recurring for some time, someone conceived the idea of testing the hoist with the load in position and without disturbing the position of the armature. It was then found that, by reason of the large overloads carried, the commutator bars were burned considerably, leaving the mica in places above the bars so that the armature would sometimes stop with the brush resting on the mica and cause an open circuit.

To overcome this two more brush holders were added, the supposition being that the increased brush capacity would reduce the sparking and there would also be less likelihood of more than two brushes of opposite polarity being off the commutator at a time and preventing the armature from rotating.

This cured the difficulty, and when a similar trouble appeared on another hoist the same remedy was proposed. In this case I suggested that instead of adding two brush holders the commutator be slotted and a better grade of brushes substituted. This was done two years ago at a great deal less expense than the first remedy, and with the hoist in daily operation. No further trouble has developed.

P. Justus.

Cleveland, Ohio.

The Engineer's Employer

I highly commend your editorial in *Power* of Oct. 5, entitled "The Engineer's Employer," and I wish to say that the company I work for—the Consumers Power Co. of Michigan, with headquarters at Jackson—is and has been for two or more years maintaining an instruction department for the benefit of its employees. The instructors go around to the different generating plants and substations of the company, giving the men examinations. They also have weekly meetings at the various division points where any question brought up is thoroughly explained in a way that can be easily understood. We are not only instructed along our line of work, but also about the "Safety-First" rule, the result of being careless and the benefit derived from being careful.

I should like to hear through the paper what some of the other stations are doing in regard to the education of their employees.

M. Mudge.

Lansing, Mich.

Inquiries of General Interest

Advantages of Double-Ported Slide Valve—What is the advantage of having a slide valve double-ported?

W. A. L.

To obtain the desired opening with one-half the travel of an ordinary slide valve, thereby requiring less space and also reducing the power required to move the valve.

Advantages of Split-Frame and Box-Frame Motors—What are the relative advantages of split-frame and box-frame motors for street-railway service?

F. G. H.

Split-frame motors are more advantageous for inspection or removal of armatures. Box-frame motors are cheaper to construct, and their one-piece magnetic circuits are of higher electrical efficiency.

Location of Pet-Cocks on Pump Air Chambers—Where should cocks or escape valves be fitted on pump air chambers?

W. A. C.

Any cock or escape valve should be fitted well below the middle of the air chamber, not only for the purpose of drainage of water when desired, but also to prevent the escape of air; for when placed in the upper portion of the air chamber, however well the cocks or valves may be ground, there is sure to be some leakage of air, thus liberating the air cushion.

Negative Exhaust Lap—What is negative lap of the exhaust?

The terms "negative lap," "minus lap" or "minus cover" of the exhaust, signify that the valve does not cover the inside edge of the exhaust port when the valve is in the middle of its travel. The effect is to open the exhaust port earlier and close it later in the stroke of the piston, thus causing earlier release and less cushioning by compression of the exhaust.

Pressure of Water Against Side of Tank—What will be the total pressure of water against one side of a cubical tank 10x10x10 ft. if the tank is full of water at such temperature that the water weighs 62.4 lb. per cu.ft.?

W. E.

The pressure at the surface would be zero, and at the bottom would be 10x62.4 lb. per sq.ft. As the pressure would be directly as the depth, the average pressure would be $(0 + 624) \div 2 = 312$ lb. per sq.ft. and the total pressure exerted by the water against one side of the tank would be $(10x10) \times 312 = 31{,}200$ lb.

Air Required for Combustion of a Fuel Oil—What weight and volume of air would be required for the complete combustion of an oil, analysis of which shows practically 85 per cent. carbon and 15 per cent. hydrogen? E. L. W.

For theoretically complete combustion, the carbon would require $0.85 \times 2.66 = 2.26$ lb. of oxygen, and the hydrogen would require $0.15 \times 8 = 1.20$ lb. of oxygen, or a total of 3.46 lb. of oxygen. As air contains 0.23 part of oxygen and 1 lb. of air (62 deg. F.) has a volume of 13.14 cu.ft., theoretically complete combustion would require $3.46 \div 0.23 = 15.043$ lb. or $15.043 \times 13.14 = 197.66$ cu.ft. of air per pound of the oil.

Adjusting Piston Clearance—Should piston clearance be made the same on both ends of a cylinder, or if not, on which end should the clearance be greater?

S. A. D.

When adjusting the clearance with a cold engine, allowance should be made for greater clearance required on the head end to compensate for increase in length of the rods after being warmed up. With such allowance, keying or shimming tending to lengthen the rods would call for greater clearance on the head end, and if they tend to shorten the connecting-rod there should be greater clearance on the crank end.

Different Designations of Pressures—What is meant by "absolute pressure," "gage pressure" and "boiler pressure?"

G. R.

Absolute pressure is pressure above true vacuum or zero pressure. Pressure gages ordinarily have their graduations marked from atmospheric pressure and indicate pressures in excess of atmospheric pressure. The term boiler pressure, as commonly employed, signifies the effective bursting pressure which acts on a boiler and as it is the difference between the internal pressure and the external atmospheric pressure, or pressure in excess of atmospheric pressure, the terms "gage pressure" and "boiler pressure" are usually understood to mean the same thing. Hence in any case, absolute pressure is equal to "gage pressure" or "boiler pressure" plus the pressure of the atmosphere.

Irregularities Due to Connecting-Rod—If a D valve has the same lap at each end when in the middle of its travel, why will the events of cutoff, release and compression occur earlier on the return stroke of the piston than on its forward stroke?

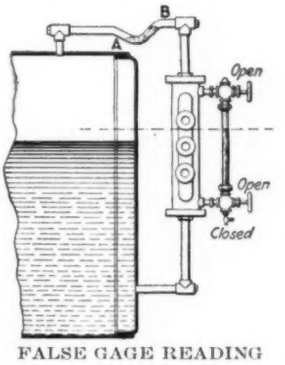
G. B.

With uniform rate of rotation, the corresponding events would occur in the same intervals of time after the beginning of the stroke, but on account of the irregularities introduced by the connecting-rod there is a greater angular displacement of the crank and eccentric for a given fraction of piston stroke from the crank end of the cylinder than from the head end. Consequently, with the same lap on each end of the valve, events during the return stroke would be accomplished for less fractional parts of the stroke.

False Indication of Water Level—With the connections of a gage column clear and all valves open, how could a glass gage show a water level higher than the actual water level of the boiler?

M. R.

If a steam loop should be caused by a bend in the steam pipe connecting the top of the water-gage column to the steam space of the boiler, similar to AB in the figure, it would cause a false reading of the water in the gage-glass for the reason that water formed by condensation of steam in this pipe falls to the bottom of the bend and fills the bore of the pipe. Steam between this bend and the gage-glass is then shut off from the steam in the boiler, and as it condenses, the pressure drops and the water rises in the gage-glass, giving a water-level-reading above the true water level in the boiler. The change of level continues until the water in the bend is forced over into the water column, when the water in the gage-glass suddenly drops to its correct reading.



FALSE GAGE READING

Amount of Concrete in Foundation—A concrete engine foundation having sloping sides, measures 25x10 ft. at the bottom and 20x8 ft. at the top, and the height from bottom to top is 10 ft. What is he number of cubic yards?

T. D.

The volume is most conveniently found by the "prismoidal formula,"

$$\text{Volume} = L \times \frac{A + a + 4M}{6}$$

in which

A = Area of one of the two parallel sides;
a = Area of the other of the two parallel sides;
M = Area of a cross-section midway between, and parallel to, the two parallel sides;
L = Perpendicular distance between the two parallel sides.

As $A = 25 \times 10 = 250$, $a = 20 \times 8 = 160$, $M = \left(\frac{25 + 20}{2}\right) \times \left(\frac{10 + 8}{2}\right)$, or $22.5 \times 9, = 202.5$, and $L = 10$ ft., then

$$\text{Volume in cu.ft.} = 10 \times \frac{250 + 160 + 4\,(202.5)}{6} =$$

2,033.33 cu.ft., or
$2{,}033.33 \div 27 = 75.31$ cu.yd.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Notes on Boiler Operation*

By C. E. Stromeyer†

SYNOPSIS—The Manchester Steam Users' Association was organized in 1854 for the purpose of reducing the number of boiler accidents. The following notes by the Association's chief engineer relate to those features of boiler practice which influence safety and which are a vital part of an engineer's or fireman's job.

The Manchester Steam Users' Association's system of boiler inspection is roughly as follows:

At every first inspection of a boiler a complete drawing is made from which the permissible working pressure is estimated. In each successive year remarks in the reports of indications of corrosion, grooving, bulging, etc., are recorded, and the progress of these defects is recorded in subsequent years. The condition of the scale, the appearance and disappearance of grease are recorded, sketches are filed of repairs, and notes are made of the fitting or removal of mechanical stokers, water softeners, etc. Thus at a glance the past history of every one of our boilers stands revealed, and if a change of treatment or of attention has occurred, resulting in new defects or in the renewed activity of old ones, our attention is at once drawn to it, and the boiler owner is given suggestions that will enable him to obviate troubles.

EFFICIENCY VS. WEAR AND TEAR

The efficiency of any type of boiler is roughly proportional to the excess of the initial flame temperature over the chimney temperature of say 500 deg. F., and the flame temperature is inversely proportional to the amount of air supply per pound of fuel. The maximum attainable temperature in a furnace is probably 4,000 deg. F., when there would be about 20 per cent. excess or unconsumed air in the waste products. With a chimney temperature of 500 deg. F., the efficiency of the boiler would be 88 per cent., if boiler radiation is not included in the loss and if there is no cold air leakage through the brickwork. If the air supply is doubled from 120 per cent. to 240 per cent., or 140 per cent. excess over theoretical requirements, the initial furnace temperature would be reduced to one-half, or 2,000 deg. F., and with this reduction the gross efficiency would sink to 75 per cent. Quite naturally, efforts are constantly being made to attain the higher result and even to go beyond it, but this extreme step means smoke and heavy fires, and the incomplete combustion means a loss of efficiency. But the attainment of the maximum possible efficiency is associated with a 16-fold intenser local furnace activity. This is due to the fact that the radiation from hot bodies increases as the fourth power of the absolute temperature.

It is therefore not surprising that increased efficiency, if due to improved combustion conditions, and therefore associated with higher furnace temperatures, should lead to increased wear and tear of the boiler.

The question that a would-be purchaser of a water softener has to decide is whether an annual expenditure of from £20 to £35 on water softening will be more than balanced by a reduction in the cost of cleaning the boiler and by an increased efficiency, the latter question being mixed up with that of adopting a mechanical stoker, which cannot be done with safety if the water is very sedimentary. Thus if boiler cleaning costs £20 per annum, this expense might be reduced to £5 by adopting a water softener, and though this would entail a slight apparent loss, it would be more than balanced by a slight increase in economy and a marked reduction of wear and tear. If, in addition, cheap slack should be available in the district, then the installation of a water softener would permit of mechanical stokers being installed, and a marked pecuniary saving could be effected.

PRECAUTIONS WHEN RAISING STEAM

A large number of boiler accidents that are not real explosions and are, therefore, not reported upon by the Board of Trade, are caused by the lighting of fires in empty boilers. The night watchman is not a boiler attendant and merely does as he has been taught with regard to setting away the fires, and if, as happens now and then, the water has leaked out over night, the watchman may either not know the significance of an empty gage-glass, or may perhaps not feel competent to test it and to refill the boiler if empty. He will therefore merely do as he has done before and put away the fires, and when the fireman arrives the damage will have been done, and the factory will have to be stopped for a day or two.

Occasionally it happens that a leak is started during the period of raising steam. For instance, the blowoff cock may not be tight or the feed valves may be leaky, in which cases water will at first show in the gage-glasses, but as soon as there is any pressure leakage commences, and the furnace tops are then exposed to the heating action of the flames.

The resulting collapses are generally of a more serious nature than the sprung seams, because they take place while steam is being generated and the boiler may have to be put out of use for one or more weeks. These cases are of the nature of unforeseen accidents, with which night watchmen can hardly be expected to deal, and it is desirable to impress them with the necessity of not proceeding with the raising of steam whenever they notice anything unusual about a boiler, for it is far better to have a delay of a few hours, due to there being no steam, than to have to shut down a factory for days because the boilers have become useless.

Where steam has to be raised rapidly, a very good plan is to nearly fill the boiler with water and to have bright fires; then the whole body of water above the firebars will grow hot, while that below the furnaces remains cold. As soon as the boiling temperature has been reached and the open safety valves are blowing off steam, the latter should be shut, the blowoff cock opened and the lower cold water run out till the lower boundary of the upper hot water touches the boiler bottom. The whole boiler will then be of a uniform temperature and the raising of steam can be proceeded with at a fairly rapid rate.

In cases of shortness of water without furnace bulging, there should never be a moment's hestitation about rapidly cooling the furnace plates. Formerly it was held that by bringing cold water or froth into contact with a red-hot plate explosive pressures would be generated, but the very costly experiments which this association carried out on a large boiler have conclusively demonstrated that, even if quite cold feed water is sprayed on a red-hot furnace top, no increase of pressure, but only a decrease takes place. The older view was probably invented in order to account for explosions the real causes of which had been carefully obscured. The steel used for modern furnaces is so mild that it readily stands the test of being heated to redness, quenched in water and then bent double. There need therefore be no fear of cracked plates.

Low-water and high-pressure safety valves, which blow off steam, are fitted to most large boilers. They relieve pressure and give the alarm as soon as the water level sinks too low; they close again as soon as normal conditions are attained. Fusible plugs are less satisfactory and should only be applied in small boilers, for when acting correctly by blowing out in cases of shortness of water before bulging takes place, they put the boiler entirely out of use until a new plug has been fitted, and very often, if they are not properly scaled they blow out without water being low. Then, also, if the alloy is not renewed every year its constituents separate from each other and the melting point is raised too high to be of use in case of danger.

THE CORROSION OF BOILERS DUE TO AIR

In corrosion due to the air which is contained in all feed waters, the action seems to be as follows: Carbonic acid attacks iron and forms a greenish salt, which is converted into iron oxide if brought into contact with water containing oxygen. The carbonic acid is then liberated and is free to reattack the iron. Thus a small trace of carbonic acid may be the cause of much corrosion, and it is, in fact, almost impossible, even under laboratory conditions, so thoroughly to remove this gas out of water that no corrosion will take place; all attempts to do this on a large scale are doomed to failure. Considerable success has, however, attended the various attempts to reduce the amount of oxygen held in solution by the feed water, more particularly with marine engines. This feed is merely condensed water, which should be practically free from air, but air is often introduced in large quantities

*Excerpts from "Memorandum by Chief Engineer" of the Manchester Steam Users' Association.

†Chief engineer, Manchester Steam Users' Association.

by the pumps, because they are deliberately supplied with it if they will not work smoothly without it, so that, generally speaking, condensed feed water may contain considerable weights of dissolved air, or oxygen. If this oxygen were to do all the harm it could, no boiler fed with aërated water would last a year, and it is not to be wondered at that some boilers do corrode very rapidly. This evil has been very materially reduced by the introduction of slow-running pumps, which do not require air cushions for their smooth working.

The mere fact that newly polished iron is as electro-negative as zinc and that nitric acid or weak galvanic currents can make its surface as electro-positive as copper, should suffice to explain, not only why one boiler or part of one boiler corrodes and another boiler or part of a boiler is not attacked, but why oxidizers like chromic acid preserve wrought iron, and some caustics, especially the ammonia salts, do not protect. Even the microstructure of steel has an influence on corrosion, pure iron dissolving with difficulty even in the ordinary acids, whereas commercial steels and irons are attacked by the mere traces of carbon dioxide, a very weak acid, and by the oxygen of the small traces of air which are dissolved in water. Unquestionably the slight differences of electric potential between ferrite, pearlite, cementite and other iron and manganese compounds which form the microscopic patterns of mild steels and irons, act like innumerable but small galvanic couples and set up currents that may prove very corrosive under certain conditions. A further complication is due to the black oxide with which rolled plates are covered; it is a double protection against corrosion, being impervious to water and also positive as regards galvanic properties, but wherever this scale is chipped off, negative iron is exposed and deep corrosion (pitting) may occur.

GALVANIC PROTECTION OF BOILERS

The practice of suspending zinc in boilers in order to create a protective current is an old one, especially among marine engineers, with whom it is looked upon as being very effective in arresting pitting, but it is uncertain whether the action is purely galvanic, whether the local galvanic action initiates passivity which gradually extends over the whole surface, or whether the protection is due to traces of the zinc salts which are produced.

The Cumberland process aims at reproducing the first-named condition, a low-voltage electric current, produced by a small dynamo, being made to circulate from iron anodes through the water to the boiler plates.

Evidently, the best way to obviate galvanic corrosion is to keep the boiler water free from soluble scales, for then the water cannot conduct the galvanic currents; but if the feed water has permanent hardness the steam user has to choose between two evils—he may allow the sulphate of lime to enter the boiler and form scale, the water being thereby thoroughly purified and made a good nonconductor, or he may remove this hardness in a water softener by introducing carbonate of soda, but then he will be feeding his boiler with sulphate of soda, which, as it concentrates in the boiler, converts the water into a good conductor of electricity and promotes corrosion.

THE CORROSION OF STRAINED PARTS

Another matter of interest is that weak sulphuric acid has a far stronger corrosive effect on strained mild steel than on unstrained steel, but the difference is not sufficiently great to permit of this test to be used for discriminating in cases of fracture between strained and unstrained portions. Possibly, however, a similar selective action may occur with such corrosive elements as exist in a boiler, and would account for grooving, those portions of a boiler that are most severely strained being attacked by the salts in the boiler water, and as these regions get thinner, and especially if the reductions are of the nature of thin lines or grooves, the local stress increases, and with it the corrosive action. If this is so, then it would follow that grooving, as distinct from pitting, would proceed most rapidly in such boilers as contained large proportions of dissolved salts.

To prevent internal corrosion in idle boilers these should be emptied and dried, trays of unslaked lime should be placed inside, and then all the manholes and other openings should be hermetically sealed. The lime will very soon absorb any moisture, carbonic or sulphurous acid that may be in the boiler, and any remaining salt or chloride of magnesia, being dry, can do no harm. In some works it is necessary to have one or more boilers always ready for starting, and then of course they had best be kept filled with water containing a litle caustic, but in all such cases it would seem desirable to devise some flue bypass arrangement whereby the idle boiler could be kept sufficiently warm to prevent condensation. It is no exaggeration to say that external corrosion, when it does occur, is far more serious than internal corrosion.

Dampness under boiler coverings is also a serious matter, as the resulting corrosion is entirely hidden from view, unless the covering is removed occasionally This is a rather expensive operation, and in the majority of cases the exposed boiler plates are found to be perfectly sound, but occasionally old boilers newly enrolled with us are found to be so deeply and widely corroded under their coverings that the only wonder is that they did not explode before being exposed, and their owners have to thank the marvelous tenacity of iron and steel for their escape from serious blame. Such cases, even though they are comparatively few, make it incumbent on us who are responsible for the safety of boilers to assure ourselves by the best possible means that this form of corrosion does not exist. It is, as is well known, due either to drippings from roofs or steam pipes, or shell-plate leakages.

EXTERNAL CORROSION OF ECONOMIZERS

External corrosion occurs at the lower ends of the inlet pipes where the feed temperature is comparatively cold. This form of corrosion is easily explained as being due to the precipitation of moisture, of which a large percentage is contained in the waste gases. If the fuel contains 4 per cent. of hydrogen, then during combustion $8 \times 4 = 32$ per cent. of oxygen is added, making 36 per cent. of moisture. This is brought up to, say, 40 per cent. by the natural moisture in the coal and in the air. If the air supply is 20 times the weight of the coal, this 40 per cent. is diluted down to about 2 per cent. and this moisture will condense itself on any surface which is colder than, say, 84 deg. F. If the air supply is reduced to, say, 15 times the weight of the fuel, condensation commences at, say, 85 deg. F. Thus here again increased economy results in increased wear and tear. It is also evident that the higher the percentage of hydrogen in the fuel, the higher must be the feed-inlet temperature, and whereas with boilers burning coke or anthracite little or no heating of the feed is necessary before sending it into the economizer, this precaution is imperative with caking and flaming coal.

Internal corrosion of ecenomizer pipes does not look like ordinary rust, but is of a spongy or graphitic nature. It is not easily detected, more particularly as economizer pipes do not allow of a close internal inspection. This form of corrosion is slow but fairly uniform, and when after 10 to 20 years' service it has eaten its way through one or two pipes, the time has arrived for renewing the whole economizer.

Many Features of Exposition To Be Preserved

Members of the San Francisco Board of Supervisors, representatives of the state administration of California and United States Congressmen joined in the conference of the directors of the Panama-Pacific International Exposition as to the essential features of the exposition that should be saved. These include the Marina, that portion of the exposition ground stretching along the shores of San Francisco Bay and embodying such features as the Column of Progress, surmounted by the figure, the Adventurous Bowman, and Yacht Harbor. The preservation of the Marina will afford a connecting link between the Federal reservation, Fort Miley on the east and the Presidio on the west. This will give the Government a military road between these two points and the City of San Francisco a boulevard extending from Van Ness Ave. on the east along the bay and the hills abutting on this body of water, overlooking the Golden Gate, through Golden Gate Park and thence to the shores of the Pacific. It is proposed to widen Bay St., which runs through the Avenue of Palms, keeping that avenue as it is now. Many of the foreign government pavilions will probably be allowed to remain as they are.

Of the 635 acres occupied by the exposition, 330 are private property, 18 are on the Fort Mason military reservation and 287 are in the Presidio. All of the foreign pavilions and state buildings except the California Building are on Presidio land. These can be saved, and many of them would last for years. The California Building is among the features suggested for preservation. This building stands on the edge of the Marina and represents the finest example of mission architecture the state has to offer. It covers nearly nine acres, cost in the neighborhood of two million dollars, and embraces, besides a magnificent reception and ball room, about five acres of the finest displays of the resources and products of California ever assembled.

The Palace of Fine Arts, acknowledged the architectural triumph of the exposition, although not constructed to be permanent, public opinion has demanded should be preserved as far as possible, with the idea of some day having the building reconstructed in permanent materials. Fortunately,

practically the entire site is on the Presidio reservation. Only a portion of the lagoon is on land that is privately owned. Quite likely the Government will be asked to devote a certain portion of its land now occupied by the state and foreign building sections of the exposition to this general parking scheme. This plan calls for the preservation of a number of buildings, including the Missouri State Building, which will probably be utilized as a clubhouse for the enlisted men of the army and navy, and the New Jersey, Virginia, Massachusetts, Maryland, Oregon and New York buildings. It is impossible to preserve any of the exposition exhibit palaces except the Palace of Fine Arts.

Canadian Engineering Tour

It was mentioned in the issue of Sept. 7 that those from the East in attendance at the International Engineering Congress in San Francisco had been invited by various bodies of Canadian engineers to return through their country. These included Canadian representative committees of members of the British Institution of Civil Engineers, the Canadian Society of Civil Engineers and the American Society of Civil Engineers, and the invitation held forth the opportunity of viewing the interesting engineering works within convenient distance of the route in the Provinces of British Columbia and Alberta.

Starting from San Francisco immediately after the adjournment of the congress, Sept. 25, under the leadership of Capt. C. W. Allen, engineer of the Dominion Water-Power Branch, the party arrived at Victoria about noon, Sept. 27.

ENTERTAINMENT PROVIDED AT VICTORIA

The travelers were met by a delegation of local engineers headed by F. C. Gamble, president of the Canadian Society of Civil Engineers and chief engineer of the Department of Lands and Works, Victoria, and taken in automobiles for a drive around the city, visiting the observatory and wireless station; then proceeding to Bamberton, about 16 miles from the city, to visit the Tod Inlet Cement Works. Following this inspection the guests were delightfully entertained at the home of the cement company's president, Mr. Butchart, where refreshments were served on the lawn by Mrs. Butchart and her daughter. In the construction of the house and many of the features in the extensive gardens, cement was most ingeniously used in imitation both of stone and rustic woodwork.

In the evening the engineers were received in the Government Buildings by the Hon. Sir Richard McBride, prime minister of British Columbia, and other officials of the province, and were conducted through the various chambers and rooms of this beautiful edifice and also through the museum, where there is a remarkable collection of mounted specimens of the animal life of British Columbia. Finally, as a much-appreciated souvenir of the occasion, each one was handed, with the compliments of the Premier, a handsome cloth-bound copy of the year-book of the province, replete with all manner of historical, political and other information, including that pertaining to the natural resources and industries. Returning to the Empress Hotel, there was a reception and collation in the ballroom.

VANCOUVER AND COQUITLAM-BUNTZEN POWER PLANTS

A night trip across Puget Sound brought the party to Vancouver, where again it was taken in charge by a committee of local engineers. A special boat was provided, and a sail of nearly two hours was enjoyed up the North Arm of the Burrard Inlet to the Coquitlam-Buntzen power houses of the British Columbia Electric Railway Co. There are two generating stations at a short distance from each other, each under a head of 400 ft., receiving water from Lake Buntzen as the forebay and Lake Coquitlam, two and a half miles distant, as the main storage reservoir. Power House No. 1 contains four 3,000-hp. and three 10,500-hp. units, and Power House No. 2, three 13,500-hp. units, all driven by Doble-Pelton waterwheels. Both General Electric and Westinghouse type generators are used. Current is generated at 2,300 volts and transformed for transmission to 60,000 volts. The Coquitlam dam is 100 ft. high, 655 ft. wide at the base, 1,200 ft. long and stores 8,000,000,000 cu.ft. of water, or the equivalent in electrical energy of 57,000,000 kw.-hr.

The local committee was under the chairmanship of G. H. Conway, who was the consulting engineer on the hydroelectric work. Others to whom acknowledgment is due for the entertainment here are George Kidd, general manager of the British Columbia Electric Ry Co., and R. F. Hayward, chairman of the local branch of the Canadian Society of Civil Engineers and general manager of the Western Canada Power Co.

The following day there was time for an automobile ride of 25 miles or so through the residential section of Vancouver and along the Marine Drive and finally through Stanley Park, before taking the train in the afternoon on the way to Glacier, which was reached late in the afternoon.

GLACIER, LAKE LOUISE AND BANFF

During the forenoon of the next day, Oct. 1, most of the members of the party inspected the Rogers Pass tunnel, now under construction through Mt. Sir Donald, and to be over five miles long. This excursion was made possible through the courtesy of A. C. Dennis, superintendent of construction for the contractors, Foley Bros., Welch & Stewart, and H. C. Barber, resident engineer of the Canadian Pacific Ry. The remainder of the day was spent in sightseeing or tramping the two and a half miles to the edge of the Great Glacier.

Much could be said of the wonders and delights of the next two days, which were spent at Lake Louise and Banff respectively, but they will be passed over hurriedly as there were no engineering excursions involved. From the station at Laggan there was the interesting trip on a gasoline tram, then the walk along the lake and a tally-ho ride to Lake Moraine with a splendid view of the Ten Peaks on the way. Also, at Banff there was a tally-ho drive to Tunnel Mountain and Buffalo Park. Omitting any reference to the grandeur of the scenery, which an engineer can enjoy if he cannot describe, this account will jump to the arrival at Calgary on Oct. 4.

CALGARY'S CHIEF POINTS OF INTEREST

Here again autos were supplied by the local engineers to get the visitors to the principal points of engineering interest with the least loss of time. Stops were made at the pumping plant, where motor-driven centrifugal pumps having a combined capacity of 20,000,000 gal. per 24 hr. deliver the water for the city's supply from the Bow and Elbow Rivers, at one of the power substations and at the diversion dam of the Canadian Pacific Ry. Co.'s irrigation works. This dam is the design of H. B. Muckleston, of the Department of Natural Resources of the Canadian Pacific Ry. Co., who had accompanied the party from San Francisco and at this point became its official conductor. Chief among our hosts in Calgary was G. W. Craig, the city engineer, who with others was responsible for a comprehensive pamphlet, issued for the occasion with the compliments of the City of Calgary and the engineers of Alberta, covering the engineering works and natural resources of Calgary and the Bow River Valley of Alberta.

Returning from this trip to the Palliser Hotel, the engineers were tendered a luncheon at which Mr. Muckleston was the toastmaster and addresses of welcome were delivered by Doctor Costello, mayor of Calgary; Doctor Blow, a member of Parliament, and Rev. Doctor Kirby, principal of the Royal College at Calgary, and appreciative responses were made by Calvin W. Rice, secretary of the American Society of Mechanical Engineers and chairman of the engineering party en tour, and G. S. Williams, the vice-chairman. F. H. Peters, chairman of the Calgary Branch of the Canadian Society of Civil Engineers; Alderman Frost and J. C. Dennis, assistant to the president of the Canadian Pacific Ry., were others to whom credit is due for the Calgary entertainment.

BASSANO AND THE IRRIGATION DAM

Taking the train again from Calgary, the party arrived at Bassano about 4:30 p.m., where autos were in readiness for the trip to the Horse Shoe Bend Dam, about four miles from the town of Bassano. The dam consists of a reinforced-concrete spillway structure 720 ft. long across the bend of the Bow River and an earthen embankment 7,200 ft. long, keeping a middle line between the heels of the horseshoe. The spillway is an Ambursen dam 40 ft. high, on top of which are 24 sluice gates, each 27 ft. wide, capable of retaining 11 ft. of water. Below the spillway a concrete carpet, or floor, 90 ft. wide, prevents the fall from scouring the bed of the stream. A power plant, installed as part of the structure, supplies current for operating the canal and sluice gates, lighting the interior of the dam and arc lights along the exterior bridge, and lighting and pumping water for the various buildings occupied by the attendants.

Two of the hydro-electric plants which there was not opportunity to visit were those of the Calgary Power Co. on the Bow River—one at Horseshoe Falls and the other at Kananaskis Falls—but a description of these by F. J. Robertson, general superintendent, was contained in the pamphlet previously mentioned. The Horseshoe plant operates under a head of 70 ft. and contains two Wellman-Seaver-Morgan double-runner horizontal turbines of 6,000 hp. each, two Jens Orten-Boving double-runner horizontal turbines of 3,750 hp., and two of the latter make single-runner exciter turbines. The generators are Canadian General Electric make, furnishing current at 12,000 volts, 60 cycles, which is transformed to 55,000 volts. The Kananaskis plant contains two 5,800-hp. single-runner vertical turbines built by the Canadian Allis-Chalmers Co., driving generators built by the Swedish General Electric Co.

In the evening the visitors were given a dinner at the Hunter Hotel as a farewell from the Alberta engineers. The speakers for the hosts were Mr. Muckleston and S. G. Porter and P. M. Sauder, while words of gratitude for the entertainment received were offered by Chairman Rice, Arnold Stucki and F. K. Curtis.

CONCLUDING FEATURES OF THE TRIP

Less than the desired time was possible at Moose Jaw on Oct. 5, but to show their eagerness to honor the travelers, the local engineers met the train with automobiles and gave the visitors a 20-min. whirl around the city while the train waited. Thus ended the formal entertainment at the hands of the Canadians. In passing, it would be remiss not to mention the uniform courtesy that the tourists received throughout from the Canadian Pacific Ry. and its attention to the comfort and pleasure of the participants in the trip.

An individual to whom no little credit is due is J. B. Challies, superintendent of the Dominion Water-Power Branch, who had been the Canadian representative at the International Engineering Congress, and the pleasure of whose company with the party was enjoyed while at Vancouver, but his duties prevented him from further participation in the trip. Well as he concealed the fact, it is doubtless fair to say that in his official capacity he was responsible for many of the arrangements of the tour, which had such a happy culmination.

Back in the States, as there was to be a little time between trains at Minneapolis and St. Paul, the engineers of those cities had prepared to show their traveling confrères a little attention, and in spite of the rain automobiles were found waiting to take the party through the residential part of Minneapolis and past the park and Minnehaha Falls, thence over to St. Paul, through the residence section of that city and past the State Capitol, winding up at the St. Paul Hotel, where tea was served.

The trip broke up at Chicago the following morning, the individuals returning from that point to their homes by the routes and trains that they elected.

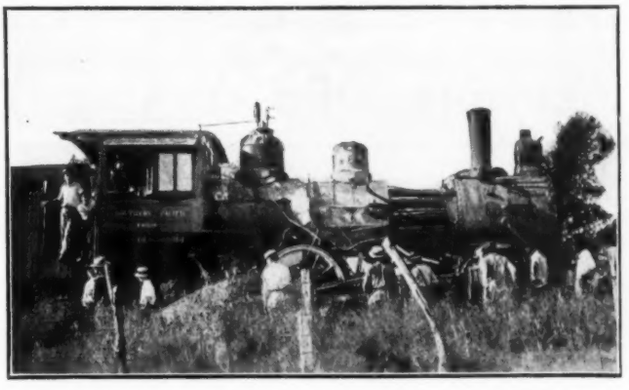
This report would scarcely be complete without a testimonial of appreciation to the New York Central R.R. for permitting its representative, G. S. Harner, who had been the official conductor of the trip to California, to return ex-officio on the Canadian tour. While his services were to be expected on the way out, it was entirely gratuitous for him to continue his kind offices when he was no longer in charge of the party, but as an experienced railroad man he was a distinct addition to the trip, constantly anticipating the difficulties that might arise and forestalling them. All have him to thank for many inconveniences they did not experience and much of the comfort they did enjoy.

Locomotive Boiler Explodes

The boiler of engine No. 224, on the Houston & Texas Central passenger train which left Austin on its run to Llano on the morning of Oct. 3, exploded while the locomotive was running at the rate of about ten miles an hour, at a point four miles northeast of Austin. One entire section of the boiler back of the smoke-stack was blown out, and pieces of it landed more than one-half mile from the scene of the accident. No one was injured. Even Dan McNamara, the engineer, and O. Morris, the fireman, both of Austin, escaped without a scratch. The fences on each side of the railroad and the telegraph poles were destroyed. A short section of the track was torn up and the engine and baggage car were partly derailed. The noise of the explosion was terrific and was heard a distance of ten miles.

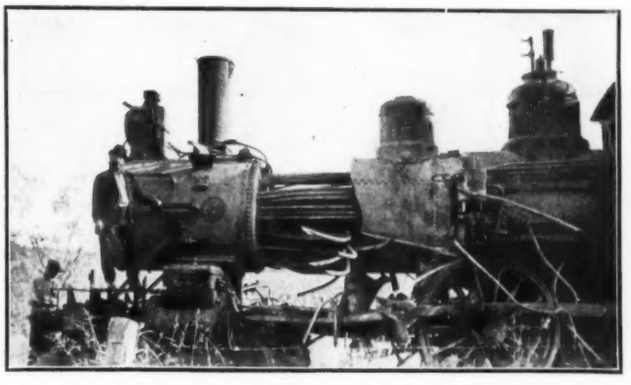
An investigation of the possible cause of the explosion was made by J. A. Shirley, of San Antonio, district boiler inspector of the Interstate Commerce Commission. His report will not be made public until it has been submitted to the commission. A committee composed of officials of the Houston & Texas Central and Frank F. Finks and Dr. A. W. Griffith, both of Austin, are also investigating the explosion. The engine had been in service about twenty years and was recently overhauled in the shops at Houston.

The board of inspectors that subsequently investigated the explosion found that a crack had developed in the longitudinal seam of the first course of the barrel of the boiler and that the crack was in such a position in the seam that it could not be detected from interior inspection, or from the



DISASTROUS EFFECTS OF BOILER EXPLOSION

exterior, previous to developing leakage. The engineer on Sept. 30 reported that a leak had developed in the front of the boiler, because of a loose stud or a crack. An examination was made by a boiler inspector and by a machinist, and they discovered what appeared to be a loose stud, which was renewed. In October the engineer reported that the right check valve was leaking and that there was a leak in the front end of the boiler. The valve was repaired, but nothing was done about the leak in the front end, as the boiler maker believed that the valve was the cause. It was the opinion of the board of inspectors that the explosion was caused by



LOCOMOTIVE BOILER, WITH TUBES EXPOSED

the crack in the longitudinal seam and that the boiler inspector was responsible for not having jacket and lagging removed, boiler inspected under pressure and leak located before approving the boiler for service.

Australia Encourages Inventors

The State Cabinet of New South Wales, Australia, on Aug. 11 decided to appoint a Patents Investigation Committee to assist in the development of inventions likely to be of general public utility.

The board will consist of a number of public officers expert in various lines of industry under the chairmanship of Mr. Griffith (Minister of Education), whose technical knowledge as an experienced patent attorney will be of considerable assistance to the board.

The board will be divided into a number of subcommittees covering the various branches of industry, and the different inventions will be submitted to the subcommittee having technical knowledge in the particular line concerned. Any ideas which, after investigation, the board is of opinion are of value to the public will be submitted by it to the various public departments likely to be able to utilize them.—"Daily Trade and Commerce Reports."

PERSONALS

William J. Aicklen, commercial manager of the Consumers' Electric Light and Power Co., New Orleans, La., has been appointed general manager of the company, succeeding S. R. Bertron, Jr., transferred. The appointment is effective Nov. 1, as announced by J. S. Pevear, president of the United Gas and Electric Engineering Corporation.

ENGINEERING AFFAIRS

Engineering Students at Illinois—The number of students registered in the College of Engineering of the University of Illinois ten days after the beginning of registration for the new year, is as follows: Architecture, 161; architectural engineering, 167; ceramic engineering, 65; civil engineering, 189; electrical engineering, 259; mechanical engineering, 238; mining engineering, 30; municipal and sanitary engineering, 31; railway engineering, 44; total, 1,184. This statement does not include the number of engineering students registered in the Graduate School.

Westworth Institute Catalog Issued—The 1915-16 catalog of Wentworth Institute, Boston, Mass., a school of mechanic arts, shows by many views the present equipment, including that in the new wing of the building. The present facilities for carrying out the aim of the institute to increase the average standard of skill and intelligence in all of the trades for which it establishes courses are covered in considerable detail. Both day and evening courses are given and include, besides carpentering, machine work, foundry and forge-shop practice, such subjects as the steam engine and the operation of power plants, applied electricity and direct- and alternating-current electrical machinery. The entrance requirements and tuition fees are very moderate.

NEW PUBLICATIONS

THE CALENDAR STEAM TABLES—By H. L. Calendar, Professor of Physics in the Imperial College of Science and Technology, South Kensington, England. Published by Longmans, Green & Co., New York. Cloth; 5½x8½ in.; 40 pages. Price, 80c.

This little book contains seven tables relating to the properties of saturated and superheated steam. In the pressure table volume and total heats are given for both Centigrade and Fahrenheit temperatures. The properties in terms of temperature are given in separate tables for values from 0 to 259 degrees Centigrade. The properties of superheated steam are similarly presented, total heat being given only in mean calories Centigrade, and volume and entropy in separate tables in terms of Centigrade degrees. The book will no doubt be useful to physicists and experimenters working with the metric system of units. A large steam diagram, in which total heat as ordinate is plotted against the logarithm of the pressure as abscissa, accompanies the book.

PROPERTIES OF STEAM AND AMMONIA—By G. A. Goodenough, Professor of Thermodynamics, University of Illinois. Published by John Wiley & Sons, Inc., New York. Cloth; 7x10 in.; 108 pp. Price, $1.25.

This collection of tables includes properties of saturated steam as referred to both pressure and temperature; volume, entropy and heat content of superheated steam from one to 800 lb. pressure; properties of mixtures of air and saturated water vapor; and of saturated, superheated and liquid ammonia. The book contains a number of features that will make it particularly valuable for practical engineering work. The properties of saturated steam are given by tenths of an inch from 0.2 up to 5 in. of mercury, and then by inches up to 30. The superheat tables are based on temperatures increasing by 10 and 50 degrees instead of on similar superheat increments. Thus when the actual temperature of the superheated steam is known, it is possible to find the properties directly without calculating the amount of superheat, and then in many cases interpolating in order to get the correct value. The ammonia tables were first issued as a bulletin two years ago by the Engineering Experimental Station of the University of Illinois. At that time "Power" published some of the tables and made the statement, which still holds good, that the values best represented the knowledge of the properties of ammonia. The tables are the most accurate now available to those interested in the properties of ammonia.

THE COST OF PUMPING WATER

In these days when so much attention is being paid to engineering costs, a little pamphlet issued by the De Laval Steam Turbine Co., of Trenton, N. J., on the cost of pumping water, will attract particular attention. Charts are given, showing the fuel cost per thousand pounds of steam for given steam pressure, superheat, feed-water temperature, cost of coal, heat content of coal and boiler efficiency. Other charts give the average cost of De Laval steam-turbine-driven centrifugal pumping units, including valves, condensers and piping, delivered and erected; the amounts to be set aside yearly to cover depreciation or amortization charges for different terms of life and rates of interest; heat-entropy or Mollier diagram for determining the number of B.t.u. converted into work by expanding steam between different initial and final conditions, with a scale for use with it and an alignment chart for determining resistance of pipes to flow of water. It will be sent free upon application.

NEW EQUIPMENT

R. I., Providence—The Narragansett Electric Lighting Co. has been granted a permit to construct a new substation on Admiral St.

Conn., Redding—The electric-light plant, owned by D. S. Sanford, was recently destroyed by fire.

N. Y., Syracuse—The Hammond Steel & Forging Co. is making improvements to its plant and will install a 425-hp. boiler, an 80-hp. motor and a pump. M. Scott is Treas.

N. J., Elizabeth—Plans have been prepared for the construction of a power plant for the General Hospital. Estimated cost, $6,786.

Penn., Philadelphia—Plans are being prepared by E. F. Durang & Son., 1200 Chestnut St., Philadelphia, for a power plant to be constructed in connection with the new building for the Misericordia Hospital.

Md., Baltimore—The Board of Estimates has authorized H. K. McCay, Harbor Engr., to prepare plans for the construction of a hydro-electric plant at Jones' Falls to supply electricity to the city.

Va., Norfolk—The Virginia Ry. & Power Co. plans to improve its plant by installing one 12,500-kw. turbo-generator auxiliary pumps and condensers. J. P. Kenny will receive inquiries.

Ga., Columbus—The City Council will engage an engineer to make investigations relative to the installation of an electric-light plant.

La., Colfax—The Big Pine Lumber Co. will rebuild its electric plant and boiler house, which was recently destroyed by fire.

Tenn., Tullahoma—Plans are being considered by the Cumberland Springs Co. for the installation of an electric-light plant.

Ky., Cynthiana—The Lexington Utilities Co., Lexington, has taken over the plant of the Cynthiana Electric Light Co. and will make improvements in the equipment.

Ky., Whitesburg—Wiley W. Gibson & Son, Mater, Ky., is reported to be interested in the construction of an electric-light plant at Whitesburg.

Ohio, Cincinnati—The George H. Streitmann & Sons Co., cracker manufacturer, will add to its power equipment.

Mich., Fenton—The Commonwealth Power Co., Jackson, Mich., will construct a substation at Fenton.

Wis., Medford—Plans are being considered by the Medford Light & Power Co. for the improvement and enlargement of its plant.

Wis., Mineral Point—The Mineral Point Public Service Co. has been granted permission to increase its capital stock to make improvements to its plant and system.

S. D., Emery—The Bradley Electric Co. has been granted a franchise to install an electric-light plant in Emery.

N. D., Glenburn—M. Thayer has been granted a franchise by the Council to install an electric-light plant.

Mo., Powersite—The Ozark Power & Water Co. will expend $25,000 for improving on its equipment.

Ark., Gurdon—F. E. Wright will install a 14-hp. boiler, a 14-hp. gas engine and a 7½-kw. generator in his theatre.

Ark., Morrilton—The Arkadelphia Light & Power Co., Arkadelphia, will install two motor pumps in the plant recently purchased at Morrilton.

Ark., Newport—Plans are being considered by the Arkansas Light & Power Co. for the installation of two engines and a turbine pump of 1,000-gal. per min.

Tex., Bryan—Fountain Bros. have applied to the City Council for a franchise to construct and operate an electric-light plant in Bryan.